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MANCHESTER MEDICAL SOCIETY

AN ESSAY ON THE BATH WATERS,

In Four PARTS:

CONTAINING

A Prefatory INTRODUCTION on the Study of MINERAL WATERS in general.

PART I. An Account of their poſſible Impregnations.
PART II. The moſt approved Means to be uſed for the Diſcovery of their Contents.
PART III. Experiments on the Bath Waters, with an Application of the foregoing Rules to a Diſcovery of their Contents.
PART IV. On the Effects of the Bath Waters on the human Body, and the Propriety of their Uſe in Medicine, with an Application of the Experiments to Medicine and Pharmacy.

By WILLIAM FALCONER, M.D. of BATH.

Quæ præſenti opuſculo deſunt, ſuppleat ætas; non enim differendum eſt tyrocinium in ſenectutem. Nam quotidiè creſcit metus, majuſque ſit ſemper quod auſuri ſumus: & dum deliberamus quando incipiendum, incipere jam ſerum ſit. Quare fructum ſtudiorum viridem, & adhuc dulcem, promi decet; dum & venia & ſpes eſt, & paratus favor, & audere non dedecet.
QUINTILIAN.

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JOHN FOTHERGILL, M. D.

DEDICATIONS are generally offered to rank and fortune alone, though when theſe are united with learning and abilities, they have certainly a ſtronger claim to our regard. For this reaſon I chuſe to deviate from the uſual courſe, and addreſs the following treatiſe to one of the firſt Names in the Science and Practice of Medicine; as, whatever may be the fate of the Work itſelf, the public muſt approve my choice of a Patron. Not but I muſt confeſs I was partly ſwayed by a private motive, wherein my ſilence might juſtly be deemed ingratitude. Your kind concern for my welfare, and the intereſt you took in recommending me to this place, would call for my warmeſt acknowledgments, were you leſs diſtinguiſhed in the profeſſion. Permit me then to offer to your notice this inlarged, and I hope ſomewhat improved Edition, and to join to ſo reſpectable a name as Dr. FOTHERGILL'S, that of

his faithful,

Bath,
Aug. 1,
1772.

and obliged friend,

WILLIAM FALCONER.

INTRODUCTION.

On the STUDY *of* MINERAL WATERS *in general.*

IN the preſent improved ſtate of Medical Knowledge, it ſeems remarkable, that ſo little progreſs ſhould have been made in ſo important a branch of it, as the Inveſtigation of the Nature and Qualities of Mineral Waters. Books, indeed, have not been wanting, as I have lately been well aſſured by an eminent Phyſician, that upwards of a thouſand Treatiſes have been written on this ſubject only. The accounts, however, tranſmitted to us by the generality of theſe Writers, are very little to be depended on, as they are moſtly filled with inſtances of the groſſeſt ignorance, or miſrepreſentation. Bold as this aſſertion may appear, I am inclined to think, that, on examination, it will appear well founded, INTROD.

and

and believe that thoſe who have been moſt converſant in works of this kind, are abundantly ſatisfied of its truth. The Author would not be underſtood, to mean a reflection on all the Books, without exception, that have been written on the ſubject; he is willing and ready to acknowledge ſeveral uſeful and important diſcoveries, which are to be found in works of this kind. It muſt, nevertheleſs, be acknowledged, that if we conſider the great advances made in the other branches of the Science of Medicine, and eſpecially in that one moſt conducive to diſcoveries of this kind, *viz.* the Science of Chemiſtry, the Knowledge of Mineral Waters has not been proportionably improved.

A certain ingenious Writer, a native of a neighbouring kingdom, who has included in his Work a Diſſertation on the celebrated Waters, which are propoſed as the ſubject of the enſuing pages, has carried his reflections on this ſubject to a great length, and made many ſevere obſervations on the Faculty reſident there, for their ignorance of the principal remedy in their *Materia Medica*. How far this may be true, does not become the Author of this Treatiſe to determine; certain it is, that, granting it were ſo, which he has by no means proved, a decency of language impeaches no truth; and had the Author obſerved this rule, his work would, probably, have found that reception in the world, which it juſtly merits by the ingenious diſcoveries it contains.

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It is hoped the following Work will be as little obvious to objections of this kind, as the nature of the thing will admit of. Opinions, indeed, and ſome, perhaps, of a pretty general nature, will be found diſputed; but hope it will be done in ſuch a manner, as not to give offence to thoſe who have written in ſupport of them. When opinions alone are controverted, it may be alledged, that no apology is neceſſary, as candour ſhould be the inſeparable attendant on learning; and no man of Science ſhould be aſhamed to receive information from whatever chanel it may be derived. Specious, however, as this argument may ſeem, the practice of the world is widely different: Diſputes of this nature have been generally managed with great acrimony, and have not infrequently degenerated from mere literary controverſies into perſonal ſatire and invective. This obſervation, though particularly true in this inſtance, is not confined to Medicine, it having been an old general remark, that men are at leaſt as tenacious of their opinions as their property. I am too well ſatisfied of my own imperfections, to deſire to enter into diſputes of this nature, and am ready to own, that, however probable the following theory may ſeem, it is by no means, even in my own opinion, free from objections. A conſciouſneſs of this, will ever incline me to receive any information, or acknowledge any error I have made. One merit, however, I hope I may pretend to, which is, that in the following Experiments I have not falſified any fact in favour of the opinions I have adopted, nor ſuppreſſed any circumſtance that may ſeem to contradict them. When any ſuch have occurred, I have related them faithfully, and, as far as reaſon, or a juſt probability would ſupport, endeavoured to reconcile them with my theory. I have not, likewiſe, taken any experiment on the credit of others, but have repeatedly made all thoſe here related. How far I have ſucceeded the world muſt judge; but as this Work is compoſed, in a great meaſure, on a new plan, ſome indulgence may juſtly be expected.

I ſhall now proceed to ſpeak of the cauſes which have prevented, or at leaſt retarded, the improvements we might have expected to have ſeen in this branch of Science. The principal of which are the following:

1. The want of chemical knowledge. That a certain degree of chemical knowledge is neceſſary to thoſe who propoſe to inveſtigate the impregnations and qualities of Mineral Waters, will ſcarce be denied: As a proof, however, of it, if we look into the books written on this ſubject, while that branch of knowledge was little cultivated, and, of courſe, few improvements made; or into thoſe of later date, whoſe Authors were defective in that Science, we ſhall be abundantly convinced of the truth of this aſſertion.

We there read of Waters impregnated with ſubſtances, which we know are (in the ſtate they are preſented to us by Nature, and of courſe the ſtate in which they are generally expoſed to the action of the Waters,) indiſſoluble in a watery fluid; or elſe of ſubſtances, which, although ſoluble in Water, we know to be mere creatures of Art, and of courſe ſuch as we cannot expect to meet with amongſt the operations of Nature. Experience likewiſe juſtifies this theory, and has proved moſt of thoſe boaſted impregnations to have been merely ideal, and reduced the number of the real and poſſible impregnations, into a much ſmaller compaſs than the Advocates for Mineral Waters would be willing to allow.

We muſt not, however, too raſhly attempt to ſet bounds to the operations of Nature, as ſeveral ſurprizing and uncommon phænomena have been produced, by means that we are ignorant of. Subterraneous fires, earthquakes, *&c.* numerous marks of which we ſee in many foſſile appearances, often interrupt the courſe of Nature, and ſometimes imitate, and at others form the ſame productions with thoſe which had iſſued from the hands of the moſt elaborate Chemiſt.

Nor muſt we always deny the impregnation of Waters with ſubſtances, from a pre-conceived opinion of their indiſſolubility in a watery menſtruum; as many bodies are capable of ſo minute a diffuſion through the body of a fluid, as to produce the ſame effects on the body, as they would have done in a ſtate of ſolution; and by that means bring them under our definition, of Medicated, or Mineral Waters.

Neither, on the other hand, muſt we, from a too great confidence in experiment, attribute too much to the diſſolvent power of either ſimple Water, or Water when combined with ſuch ſubſtances as it might meet with in the bowels of the earth, and which might increaſe its ſolvent effects. The circumſtances of theſe are oftentimes widely different, and many productions are exhibited, which vary greatly from thoſe which our Theory would, at firſt ſight, lead us to imagine; and others, which, from the great frequency of their component parts in the bowels of the earth, we might expect often to meet with in theſe re-

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This, I hope, will prove a ſufficient anſwer to thoſe who alledge, that all attempts to diſcover the properties or effects of Mineral Waters on the human body, by chemical experiment, or analyſis, are vain and inſignificant, as there are many effects produced by them, which are not to be accounted for from any diſcoverable impregnation. It cannot, indeed, be denied, that there are ſeveral ſuch ſtill; yet it muſt be owned, likewiſe, that there were many more formerly, whoſe effects ſeemed equally inexplicable.

Later experience has, however, demonſtrated, that they are not all at leaſt equally inſcrutable; and as many of their effects have, by the aſſiſtance of Chemiſtry, been explained on juſt and rational principles, what reaſon have we to deſpair that the remainder will, in time, be rendered equally clear? To aſſert the contrary, would, if applied equally to every branch of learning, preclude all ſearch whatever; and had it been formerly obſerved, would have prevented our acquiſition of many uſeful and important diſcoveries which we now enjoy.

An accurate knowledge of Chemiſtry is likewiſe requiſite in the examination of Waters, to diſtinguiſh their original contents from thoſe which are only the product of the Experiments. From inattention to this circumſtance, many miſtakes have been committed, and many ſuppoſed diſcoveries have been made of impregnations, which never had any exiſtence in the Water before theſe were made.

2dly. Abuſe and confuſion of terms. This cauſe is nearly connected with the former, and proceeds, in a great meaſure, from the ſame origin; it having been an old obſervation, that no ſcience ever arrives at any conſiderable degree of perfection, until its terms are accurately defined. If this rule holds general, we may pronounce this branch of knowledge to be at an exceeding low ebb, as there are ſcarcely two Writers on the ſubject of Mineral Waters, who have applied the ſame ſignification to ſimilar expreſſions. It is, indeed, greatly to be doubted, if the Authors themſelves had any poſitive idea affixed to many of their terms, as they ſeem to be more frequently drawn from ſome idea of a poſa poſſible, or, as their fancy might ſuggeſt, probable production, than from Experiment tending to prove, that ſuch facts had really happened. This imperfection is juſtly charged on moſt of the ancient Writers, and, indeed, was more pardonable in them, than in many of their ſucceſſors the Moderns, who, notwithſtanding they have wrote ſince more accurate and explicit ideas were affixed to chemical terms, have ſtill purſued the ſame unintelligible path with their predeceſſors. Several Writers on this ſubject have been grievouſly faulty in this reſpect, as many of their terms are inexplicable, others contradictory, and no ſmall ſhare of the remainder ſcarcely differing more from each other, than they do from thoſe things, which, from a view of their name, we ſhould imagine they were intended to expreſs.

Many of theſe Writers, like the Alchemiſts of old, have made a notable uſe of theſe confuſed and unintelligible terms, in order to cover their own ignorance, juſtly ſuppoſing, that no one could object to terms, however unintelligible, which the cuſtom of their predeceſſors had eſtabliſhed;

the very obſcurity of which would lead many to believe implicitly in the ſagacity and learning of the Author, while the means of its detection muſt be in the hands of few, and thoſe, perhaps, too deeply intereſted to make the diſcovery.

Had this obſtacle been properly attended to in former times, we ſhould, in all probability, have ſeen many of the unmeaning and unintelligible terms, which now diſgrace this branch of learning, exploded, and new and explicit ones ſubſtituted in their place.

3dly. Want of method has been likewiſe a principal ſource of this obſcurity, as it neceſſarily produces circumlocution, and not infrequently confuſion.

From hence it comes, that many of theſe Authors are ſo dark and unintelligible in their ideas, and, conſcious of this defect, they were, probably, unwilling to part with terms ſo well adapted to their purpoſe, being deſirous, like the Painter of old, to cover with a veil what they were unable to expreſs.

4thly. Deſire of gain has likewiſe been the cauſe of much ignorance, as well as falſhood and miſrepreſentation on this ſubject. The practitioners have been fearful of making, and ſtill more of diſcloſing, the event of Experiments made on the Mineral Waters which they attended, though from them they might be chiefly expected. They dreaded leſt the impregnations ſhould be diſcovered to be ſuch as might be eaſily imitable, in equal perfection, by the hand of Art, which would deprive them of many of their lucrative ſources, by preventing the reſort of people to a diſtant place, for what would be ſo eaſily procurable at home.

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Another reaſon, and perhaps a more juſtifiable one, is, that ſince a Patient's good opinion of the efficacy of his medicines is, in many caſes neceſſary, and at all times favourable to his cure, by keeping up his ſpirits, and ſecuring his obedience to the Phyſician's directions; ſhould many of theſe boaſted arcana, however efficacious in practice, be at once develloped, and diſcovered to be no more than the moſt common and ſimple ſubſtances, it might diminiſh his confidence in the remedy, and by that means deprive him of many of the advantages otherwiſe to be expected from it. They were, therefore, unwilling to encourage ſcrutinies of this kind, being contented with a few practical obſervations on the effects of the Waters, and deſirous that the chemical diſcovery of their contents ſhould, like the Roman Palladium, remain locked up in the moſt ſecret part of the Temple, ſcarce to be looked on even by the Prieſts themſelves.

The celebrated Writer before-mentioned has carried his arguments on this head much farther, and has brought ſeveral grievous accuſations againſt the Faculty of Phyſic, as having, for lucrative motives, ſo miſrepreſented or falſified the qualities of the Waters where they reſided, as to adapt them to every diſorder, or ſtate of it, incident to the human body. Were this charge true in its full extent, grievous indeed would be the imputation, as it would be reducing the principles of their profeſſion to the ſtandard of the loweſt Empyriciſm; and, what is of ſtill greater conſequence, how melancholy muſt be the ſituation of the generality of thoſe who apply to ſuch Practitioners for relief! To ſuch, indeed, the advice of a late great and worthy Phyſician might be well applied—*To peruſe the ſixth Commandment.* We may be, however, fully ſatisfied, that this Author has carried his reflections to a very unjuſtifiable length. Some few might, perhaps, be found, to whom ſuch an imputation might be applicable, as it can never be expected that the Profeſſors of Medicine ſhould, more than other men, be uniformly, and without exception, juſt and honeſt. But we may reſt aſſured, that the number of theſe is very ſmall, in compariſon with thoſe who would even ſhudder at the thought. Some prejudice, perhaps, is inſeparable from our nature; it is not, therefore, to be expected, that our profeſſion alone ſhould be diveſted of it.

Many Practitioners, ſeeing the good effects of the Waters at which they reſided, might be tempted to extend their uſe to more caſes than their unprejudiced reaſoning might fully juſtify. But is not this the caſe with the Profeſſion in general? What Practitioner can ſafely aſſert, he has not

INTROD. ſome partiality for a particular medicine above the reſt? I believe few can diſavow it; and if they ſhould be ſo blind to their own prejudices, thoſe who would examine their practice would ſoon make the diſcovery for them.

5thly. The indolence of Practitioners, likewiſe, has been a cauſe that has powerfully contributed to retard the advancement of this branch of Medicine. That our principal information, in caſes of this kind, muſt be drawn from obſervation of their effects on the human body, is not to be doubted. But, on the other hand, we can neither make theſe properly, nor attribute the effects to their true cauſes, unleſs the contents of the Waters that produce them were aſcertained, which can only be done by Chemical Analyſis. The obſervation of their effects, though by no means, if accurately performed, the leſs difficult taſk, has been more attended to, as it was neceſſarily coincident with the Practice of Phyſic; but the latter, though proper likewiſe to be cultivated by every one who would practiſe on a rational footing, not being ſo obviouſly connected with it, has been more neglected. It muſt, indeed, be acknowledged, that the latter has ſome diſagreeable circumſtances attending it. The Experiments neceſſary on ſuch occaſions, though at firſt view, to thoſe who have never been concerned with them, they may appear agreeable and entertaining, are, many of them, diſagreeable and troubleſome, either from the nature of the operation, or the quality of the ſubſtances uſed in them. Moreover, not a few of theſe are remarkably tedious, from the length of time taken up in performing them, and the care and attention of mind requiſite to obſerve, and mark down all the different changes that occur during that period. What adds greatly to this is, the neceſſity of ſeveral of the moſt tedious of theſe proceſſes being frequently repeated, in order to draw any certain concluſions from them, as the ſlighteſt variation may cauſe a difference in the product, which will require a renewal of the Experiment.

In the foregoing part of this Introduction, I have mentioned an acquaintance with Chemiſtry as a requiſite qualification

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A knowledge of this kind is not to be gained from hiſtorical deſcriptions, and can only be learned by habitude of performing the Experiments.

To the fatigue and trouble, therefore, of the one, and the time requiſite for the attainment of the other, as it is, in fact, beginning a new ſtudy, which few are willing to ſubmit to, muſt be attributed, in ſome degree, the ſlow progreſs of this branch of Science.

6thly.

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6thly. Prejudice of opinion in favour of ſome particular theory, has likewiſe often miſled many of the Writers on this ſubject, who had formed their opinions before they made their experiments. It is probable, therefore, that many of thoſe which ſeemed contrary to their opinion were ſuppreſſed, or miſrepreſented; while others that ſeemed to favour it were carefully remarked.

Such are the moſt obvious cauſes that have retarded the improvement of the knowledge of Mineral Waters: But there is likewiſe another complaint very frequently made of Books of this kind, *viz.* that they ſeem to be written to the learned only; their meaning being ſo enveloped by terms of Art, as to render them unintelligible to the reſt of the world. This evil, indeed, is ſcarcely to be remedied, as every Science finds it neceſſary to adopt peculiar technical terms to expreſs the complex ideas, to avoid a tedious circumlocution, hardly more intelligible than the terms themſelves.

The ancient Writers, it muſt be owned, were extravagantly addicted to abſtruſe

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terms, which they uſed to expreſs even the moſt ſimple ideas. Later improvements have greatly diminiſhed this formidable ſquadron, and opened the avenues to this branch of learning, by reducing them to a few terms, and thoſe ſimple, expreſſive, and eaſily underſtood.

The uſe of an accurate chemical examination of the Waters, will, it is hoped, want no proof, with men of learning and candour. Some cavils have, however, been frequently raiſed againſt any attempts of this kind, as being impoſſible to be brought to the deſired degree of perfection; and, therefore, more apt to miſlead, by ſubſtituting an uncertain or falſe theory, in room of an approved method, which time and experience had confirmed. The firſt of theſe objections has been, as I hope, already removed; and it might be aſked farther, whether a ſearch into the cauſes of effects is unworthy the Phyſician, or Philoſopher?

To the ſecond I would anſwer, that no attempt is made to overthrow the good effects of the Waters in thoſe caſes which experience has juſtified, or extol their uſe in others, which it has condemned. The Author is far from wiſhing to ſee a Syſtem of Medicine, or, indeed, the application of any particular article of it, founded on theory only independent of practice. But is not a ſearch into the cauſes of effects conſiſtent with a due regard to practical knowledge? Do they not mutually illuſtrate each other? But I hope it is needleſs to purſue this argument farther. I will venture, however, to point out a few of the advantages which might accrue to the public, from a work of this kind, if accurately performed.

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Were the contents of the Waters aſcertained, it would be likewiſe of ſervice to thoſe Practitioners who reſide in diſtant places, who have no opportunity of making experiments on, or of ſeeing the effects of the Waters. They would then be enabled to judge of the proper application of theſe Waters in certain diſorders: For being acquainted with the ſubſtances with which they are impregnated, and the effects of thoſe ſubſtances on the human body, they may, by their knowledge of the one, form a better judgment of the other. It

INTROD. is needleſs to expatiate on the uſe of this. Moreover, as an ingenious Writer has well obſerved, a farther advantage ariſing from the analyſis of Mineral Waters is, that it furniſhes us with the means of making artificial combinations to reſemble them. It enables us alſo to compare the qualities, and to aſcertain the variety of the Mineral Waters which Nature affords us, and to arrange them under proper claſſes. It aſſiſts us alſo, in ſome meaſure, to make new diſcoveries; for ſhould a Water preſent itſelf to our view, of ſuch ſenſible qualities, as to be evidently efficacious, our beſt method of judging, in many caſes at leaſt, of its uſe in Medicine, would be to aſcertain its reſemblance to ſome other Water, with whoſe contents and qualities we were already acquainted. Some of them, indeed, whoſe impregnations are of a ſimple nature, and conſiſt of ſubſtances whoſe effects are ſufficiently aſcertained, and which are found in the Water in the ſame ſtate in which we uſe them, are eaſily inveſtigated, with regard to their qualities, from the known effects of that ſubſtance when employed in Medicine. But this is far from being always the caſe. The greateſt part of the impregnations of Mineral Waters are of a compound nature, and form ſuch combinations as we have no opportunity of ſeeing, and, of conſequence, judging of their effects in any other circumſtances than as contained in Mineral Waters. With reſpect to theſe, our means of diſcovering, and our capacity of judging of their impregnations, though much improved of late, are ſtill very confined. Even when we are ſatisfied of the exiſtence of a ſubſtance there, we are not always able to account ſatisfactorily for its preſence, or by what means of union with the Water it comes to make part of the impregnation. We cannot always diſtinguiſh likewiſe what proportion of each ingredient is contained in the compound, or what proportion each of theſe may bear to any given quantity of the Water. Granting, however, that all theſe were accurately laid down, we may reaſonably believe, from the nature of ſeveral of the ſubſtances that form theſe impregnations, the great difficulty of collecting theſe together, and the ſtill greater of combining them properly by any artificial means hitherto diſcovered; that our beſt method of forming

INTROD. a judgment of the effects of any Mineral Water that ſhould occur to our notice in the forementioned circumſtances, would be (as was before obſerved) by aſcertaining its ſimilitude to ſome other, whoſe nature and contents were already inveſtigated; as we ſhould be likely to meet with more exact parallels to it in nature, than what could be procured by any artificial preparation whatever. Theſe may be eſteemed the advantages that would accrue to Medicine in general, from the cultivation of this branch of Science; but a perfect knowledge of the Chemical Contents of the Waters, would be likewiſe of peculiar ſervice to the practiſing Phyſician at the place.

The effects produced by Mineral Waters are obſerved to vary greatly, according to the circumſtances in which they are adminiſtred, independent of thoſe which relate to the diſorder. The active principle, in many of theſe, is of a very fugitive nature, and, except peculiarly attended to in the mode of exhibiting the Waters, apt to diſappoint our expectations from them, either by its eſcape, or change of nature. A knowledge of the nature of this ſubſtance will afford us great inſtruction with regard to the method of adminiſtring the Waters in ſuch a manner as to preſerve their full effect, if deſired, or, what is likewiſe of great conſequence, to moderate this, without deſtroying it entirely, in ſuch a manner as may beſt ſuit the ſtate of the diſorder and circumſtances of the Patient. A knowledge of the contents of the Waters would be likewiſe of great ſervice on another account: Moſt of the Mineral Waters are very apt to have their component parts ſeparated, (which deſtroys their original effect,) on admixture of almoſt every foreign body. As it is often judged neceſſary to take ſome medicines along with, and frequently in the Waters, a knowledge of this kind would inſtruct us in the choice of theſe, either to ſelect ſuch as would leaſt alter their original nature, or elſe, from a knowledge of the compound formed by the Medicine and the Waters, to enable us to form ſome judgment of the effects likely to be produced by ſuch a combination.

I ſhall now proceed to give the plan of the enſuing Work; and, firſt, ſhall premiſe

INTROD. miſe an account of Mineral Waters in general, and of thoſe ſubſtances with which they are capable of being impregnated.

Secondly, I ſhall give an account of the moſt approved means to be uſed for diſcovering theſe impregnations.

Thirdly, I ſhall relate my Experiments made on the Bath Waters, and endeavour to apply the foregoing rules to the diſcovery of their contents.

Laſtly, I ſhall make an application of the whole to the practice of Pharmacy and Medicine.

PART I.

On the poſſible IMPREGNATIONS *of* MINERAL WATERS.

CHAP. I.

GENERAL DIVISION *of* WATERS.

WATER has been divided by the Chemical Writers into two kinds, but this is not quite correct, as we know but one kind of Water. Whether this Water be an element, or a compound, is not at preſent to our purpoſe to enquire; it ſeems, however, to have as good a title to the epithet *elementary* as moſt bodies.

Water, as it is capable of being united with many ſubſtances, may, from a perfectly pure ſtate, to that of the greateſt impurity, undergo various degrees of impregnation. Hence it is divided into *ſimple* or *common,* and *compound* or *mineral.*

This diviſion muſt be rather imperfect; firſt, becauſe we know no Water perfectly free from ſome degree of impregnation; and, ſecondly, as this diviſion is only from different degrees of the ſame quality, it muſt conſequently be inaccurate.

Definition of what is underſtood by *common Water.*

But by *common* Water they would underſtand ſuch whoſe impregnations are not obvious to the taſte or ſmell, and which has no ſenſible action on the human body.

What by *mineral Water.*

By *mineral,* where it has the contrary properties.

Even in common Water, according to this diviſion, there are various impregnations, which may be chemically diſcovered from the Waters of the atmoſphere, from whence all the reſt proceed, to that of ſprings, rivers, and lakes.

CHAP.

CHAP. II.

On MINERAL WATERS *ſtrictly ſo called.*

WERE we to attend to the various characters and analyſes that have been given in Books of the different Mineral Waters, we ſhould, at firſt ſight, be led to imagine, that there was a great diverſity of them, but, on examination, the contrary appears evident.

It has been before obſerved, that theſe facts have been in general groſsly miſrepreſented, and as ſuch can never be the foundation of rational concluſions. I ſhall not, therefore, think it neceſſary to pay much regard to thoſe Authors who wrote whilſt Chemiſtry was in a very imperfect ſtate, but rather, in ſuch a complicated caſe, prefer reaſoning *a priori*, according to the advice of a celebrated Profeſſor at *Edinburgh*, and then ſee if the concluſions drawn from thence are compatible with ſuch facts as can be depended on.

In order to do this more clearly, I ſhall, before I enter into particulars, lay down ſome general propoſitions which will ſerve to explain my reaſoning on theſe ſubjects.

I. The impregnation of Mineral Waters muſt conſiſt of native foſſile ſubſtances.

II. Of theſe ſuch only can be expected to be found as Water is capable of being united with, by any means that we can ſuppoſe to exiſt in Nature.

That the former of theſe propoſitions, in its general ſenſe, muſt hold true, appears pretty evident. It admits nevertheleſs, if taken ſtrictly, of ſome exceptions, as we have inſtances of vegetable and animal matter, and of ſome ſaline ſubſtances, which were generally thought to be of merely artificial production, being diſcovered in Mineral Waters. The cauſe, however, of moſt of the impregnations of this kind hitherto diſcovered, has been found to be owing to ſome circumſtances reſpecting the ſituation of the ſpring, as its proximity to places which contain ſubſtances of this kind, and where they might be liable to be waſhed down into it; or where they have been artificially in-

introduced into the courſe of its current; in which caſes it might receive from them an accidental impregnation. But as theſe rarely occur, and never with reſpect to the two firſt mentioned ſubſtances, except in circumſtances which, perhaps, cannot fairly be aſcribed to Nature, I can ſcarce, with propriety, admit them into the Catalogue of Native Impregnations of Mineral Waters.

With regard to Saline Subſtances, inſtances have, indeed, been produced of ſome of theſe, which have hitherto been imagined to be merely artificial productions, being diſcovered in this manner.

Some of them may, however, be eaſily accounted for, in all circumſtances where any impregnations of the foregoing kinds are likely to be met with, as ſeveral of them may be produced in conſequence of the changes to which thoſe bodies are liable. Theſe, however, as was ſaid before, as only happening like the former, in accidental circumſtances, I cannot be underſtood to comprehend. We have, nevertheleſs, ſome accounts which favour the opinion of the exiſtence of ſome impregnations of this nature, in circumſtances where no cauſe of a ſimilar kind could, with any tolerable degree of probability, be aſſigned.

There is, notwithſtanding, great reaſon to believe, that theſe appearances, when they do occur, are owing to ſome accidental interruptions of the courſe of Nature, produced by ſome of the cauſes mentioned in the Introduction. But as theſe very interruptions make a part of the Hiſtory of Nature, and happen in general, in conſequence of ſome changes occurring in the courſe of it, we cannot properly reject the ſubſtances formed in conſequence of them from the liſt of Natural Productions. Inſtances of this kind are, however, extremely rare, and when they do occur, are generally in ſo ſlight a degree, as to bring the Waters that contain them, under my firſt diviſion of *common* Water.

In order to explain my ſecond propoſition, I ſhall endeavour to ſhew by what means Bodies in general may be united with Water, and which of theſe means of union are likely to occur in the courſe of nature.

Bodies may be united with Water in three ways; by ſimple *Diffuſion*, *Mixture*, and *Solution*. As to the firſt of theſe, we know that the ſpecific gravity of Bodies is relatively decreaſed, in proportion as their ſurface is augmented: Therefore, by a diviſion of Bodies into an infinite number of ſmall parts, they may be made to remain ſuſpended in a fluid of leſs ſpecific gravity than themſelves. Thus Gold, Platina perhaps excepted, the heavieſt body we are acquainted with, may be brought by theſe means to continue for a time ſuſpended in, and even to float on, the ſurface of the lighteſt fluid known, viz. *Æther*. It is proper to obſerve, that all bodies whatſoever, if ſufficiently comminuted, are poſſible to be united with Water in this manner; whereas, only ſome peculiar bodies, and many of them only in a peculiar ſtate, are capable of being united with it by the following methods.

The union, however, of Bodies with Water, in this way, is merely mechanical, and cannot properly be called a chemical combination. Whether this ever occurs in Springs, in ſufficient degree to bring them under our Term, *Mineral*, admits of a doubt. Some circumſtances, to be mentioned hereafter, incline me to favour the opinion that it does ſo. It is certainly poſſible, and ſeemingly not unlikely to happen with reſpect to ſome bodies, though as yet we have very few inſtances adduced in proof of it. Bodies are likewiſe capable of being united together in another manner, in which, certain of their original properties are, on their junction, deſtroyed, and new ones produced in the compound, different from what either of the component parts were before poſſeſſed of. This method, the modern Chemiſts have diſtinguiſhed by the name of *Chemical Mixture*. We are not certain, however, that this ever occurs in Mineral Waters. Some circumſtances would lead to a diſtant ſuſpicion of it, but we have ſcarcely ſufficient grounds on which we can build even a probable ſuppoſition.

I would not, however, by this be underſtood to ſay, that no compound ſubſtance of this nature is to be found in Mineral Waters. On the contrary, when the ſubject comes to be examined, it will be found that ſimple ſubſtances, properly ſo called, make but a very ſmall part of the Catalogue of theſe Impregnations. I only mean to comprehend thoſe, wherein the ſubſtances, united with the Water, may be ſaid to form with it a chemical mixture.

The moſt general, therefore, and, indeed, I may almoſt ſay, univerſal method by which Mineral Waters become impregnated, is by *Solution.* As this word is here taken in a ſomewhat more confined ſenſe than its common acceptation, and, in ſome meaſure, in contradiſtinction to the two foregoing, viz. *Diffuſion* and *Mixture,* it will be proper to give ſome previous explanation of the ſenſe in which I propoſe to make uſe of it.

When a ſolid body immerſed in a fluid is divided by it, and uniformly diſperſed, ſuſpended, and retained in it, it is ſaid to be diſſolved, and the operation is called *Solution.* This is the general ſenſe, but it may be extended to the union of two fluids together. The body to be diſſolved is called the Solvend, and the fluid which diſſolves it the Solvent, or menſtruum. In Solution, the parts of the Solvend are ſo intimately and equally applied to the Solvent, that in the moſt minute portion of the one, there is part of the other preſent. This mode of union differs from the two foregoing in ſeveral inſtances. Thoſe, however, which are moſt applicable to our purpoſe, are the following.

It differs from Diffuſion, in that the latter, as we generally meet with it, is only temporary, and the diffuſed body, on its ſtanding ſome time unmoved, falls to the bottom.

N. B. This ſometimes happens in ſolution, but then it is always in conſequence of ſome decompoſition of the diſſolved ſubſtance, which is not the caſe in the precipitation which takes place in diffuſion.

The body that is diffuſed, will not paſs a filtre with the fluid in which it is diffuſed.

When a ſolid body is diffuſed through a fluid, the latter is never perfectly clear. This, however, is not always diſcoverable by the naked eye, but may at all times be found out by microſcopical examination.

From *Mixture* it differs, that in ſolution there is no change of qualities, but only the Solvends turning fluid, whereas in mixture, a neutral, or tertium quid, is always produced.

In ſolution, more than two bodies may be joined together, but only two in mixture.

In ſolution, likewiſe, nearly the ſame degree of heat ſerves to volatilize the body as when ſeparate, which is not the caſe in mixture. Theſe are the principal diſtinctions between theſe modes of combination of bodies with Water. Others, indeed, might be mentioned, but I think theſe ſufficient to anſwer my purpoſes here.

But in order to determine accurately all the poſſible Impregnations of Waters, I ſhall take a view of the different forms of bodies, and by examination of each, according to the propoſitions before laid down, endeavour to judge, from thence, of the probability of their being met with in a ſearch of this kind.

As to my diviſion of Bodies, I propoſe to make uſe of that laid down by the celebrated Profeſſor at Edinburgh, as before-mentioned, being the moſt conciſe, extenſive, and clear, of any yet publiſhed.

A compleat diviſion of this kind, that will include all the Bodies in Nature, is not to be expected; however, moſt Bodies, ſome few excepted, of little conſequence to my preſent purpoſe, may be reduced to the five following heads, viz.

1. Saline.
2. Inflammable.
3. Metallic.
4. Earthy.
5. Aërial.

CHAP.

C H A P. III.

Of Saline Mineral Waters *in general.*

THE firſt of theſe that occurs to our obſervation, is * *Saline Bodies.*

An univerſal characteriſtic of theſe ſubſtances is Solubility in Water. They vary, indeed, conſiderably from each other in the proportion in which they diſſolve, inſomuch, that ſome have denied the ſolubility of ſome of them altogether.

It is now, however, inconteſtibly proved, that they all poſſeſs this quality in ſome degree. From this general property we might expect to ſee them often make a part of the impregnations of Mineral Waters; and indeed few ſprings have been diſcovered entirely free from ſome degree of a ſaline quality. Notwithſtanding, however, this general ſolubility, what was laid down in the firſt propoſition muſt be attended to, that only ſuch as are native foſſile ſubſtances can be admitted. From inattention to this circumſtance, and neglect or ignorance of the proper methods of diſtinguiſhing them from each other, many ſuppoſed diſcoveries have been made of certain ſaline ſubſtances in Mineral Waters which our reaſoning *a priori*, might have informed us we could never expect to meet with there, and which a more accurate examination has detected to be only miſtakes of theſe for ſome other native ſaline ſubſtance reſembling them. Great caution is, however, requiſite in laying down general rules with reſpect to this claſs of bodies, as ſome very ſlight alterations in the manner of their production are capable of making great difference in the nature of the Salt produced.

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* Saline bodies are ſuch as, when applied to the tongue, give the ſenſation of Taſte, and are ſoluble in Water. Some have added, that they are fuſible in the fire, and not inflammable, without the addition of ſome other ſubſtance. Theſe qualities, however, are now generally rejected, as not holding univerſally, ſince ſome ſaline ſubſtances cannot be fuſed by the moſt vehement force of fire we can apply; and others are found to be of themſelves inflammable. There is, however, ſome reaſon to believe, that the latter of theſe qualities is owing to ſome ſmall portion of inflammable matter accidentally mixed with it.

I ſhall now proceed to ſpeak of particular * Saline Subſtances, beginning with the Simple, and proceeding on to the Compound. I do not mean to include the Metallic and Earthy Salts under the latter head, as thoſe ſhall be ſeparately treated of when I come to ſpeak of Metallic and Earthy Subſtances.

Diviſion of Saline Mineral Waters into ſimple and compound.

Of MINERAL WATERS *impregnated with* SIMPLE SALINE SUBSTANCES.

Section I.

I ſhall take the ſimple Saline Subſtances as nearly as poſſible in their order of ſtrength, beginning with the Acids.

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* Saline bodies are either *ſimple* or *compound*. By *ſimple* ſaline bodies, I do not mean to aſſert, that they are abſolutely ſo, but only that they are bodies which we have never yet reſolved, or ſeparated into their component parts, in oppoſition to the *compound*, whoſe conſtituent parts we are acquainted with. Simple ſaline bodies are either *Acids* or *Alkalies*. An Acid is a ſaline body of a ſour taſte, and poſſeſſes the particular property of changing vegetable juices that are blue to a red colour. Acids are diſtinguiſhed into four kinds, according to the ſubſtances from which they are got, *viz*. I. *Vitriolic*, as being uſed to be got from a ſubſtance called Vitriol. II. *Nitrous*, from Nitre. III. *Muriatic*, from Muria, or Sea Salt. IV. *Vegetable*, from Vegetables. *N. B*. There is reaſon to think, that there are other kinds of Acids diſtinct from theſe. But their nature and properties are not yet ſufficiently aſcertained.

Among

Acids. Vitriolic Acid.

Among theſe the Vitriolic Acid claims the firſt place*.

Whether this ſubſtance, in its ſeparate ſtate, has ever been found a native foſſile, has long been the ſubject of much doubt among the natural Philoſophers. To aſcertain this point would be a matter of great conſequence; as, were this fully

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* The Vitriolic is the moſt powerful of all the Acids, diſlodging all the others from Alcaline Salts, both fixed and volatile, and from the ſoluble Earths, and taking poſſeſſion of them itſelf in their place. It is likewiſe capable of being rendered the moſt concentrated, in which ſtate it is the ſtrongeſt of all the Acids, containing the largeſt quantity of pure Acid in proportion to the phlegm or water. It is found in two ſtates, a fixed, and a volatile one, the former of which is now meant. When concentrated to the higheſt degree we generally arrive at, its ſpecific gravity is nearly as 18$\frac{10}{7}$ to 10 of water, which is conſiderably more ponderous than any other fluid we are acquainted with except quickſilver. It is perfectly fluid, colourleſs, inodorous, and tranſparent, when pure, contrary to what † *Neumann* alledges, and its aſſuming an icy or butyraceous conſiſtence in the cold, as well as its brown colour, is now found to be owing to a portion of inflammable matter mixed with it. As to its properties with regard to other bodies: When joined with the other Acids it effervesſces, and generates heat with them. It unites alſo with all the Alcalies attended with heat, and when they are in a cryſtallized or mild ſtate, with a large diſcharge of air, and ebullition, called Effervescence. It unites alſo with oily bodies of all kinds, with heat, effervesſcence, and fumes. It is capable of being united with ardent ſpirits, or alcohol, and with the latter forms the ſubſtance called Æther. It does not unite

† *Neumann*'s Chemiſtry, p. 161.

with

proved, we could then have no doubt of the poſſibility of its being found in Mineral Waters, on account of its ſtrong attraction to, and eaſy and intimate union with, water; inſomuch that, when moſt concentrated, it always retains a portion of this ſubſtance. The notion of the preſence of an acid in ſprings is of antient date, and at laſt came to be applied to all

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with ſulphur. It unites with all the metals except gold, and even that is doubtful. It diſſolves zinc and iron, only when in a dilute ſtate, and copper when rather more concentrated: The remainder of the metals it only acts on in a boiling heat, which, on cooling, are precipitated in a corroded ſtate. It unites with all the abſorbent earths, and with them forms different ſaline compounds. It joins water very eaſily, and with it, in a fluid form, generates heat in the greateſt degree of any of the Acids, but when converted into ice, it generates cold with it. It attracts water from the atmoſphere, and, as ſome think, unites with mephitic air. It prevents or obſtructs all the three kinds of fermentation, and is, therefore, antiſeptic. I before obſerved, that this Acid is ſometimes got in a volatile ſtate, in which it is ſtrongly odorous. It is gained in this manner from all inflammable bodies, with which it is united by nature or art. In this ſtate leſs acid ſaturates more alkali, but any of the other three Acids diſlodges it from it, or decompoſes the neutral ſalt formed by it, as does the fixt vitriolic Acid. Its action on oily matters is inconſiderable, probably on account of its diluteneſs. It produces no æther with alcohol. It diſſolves metals in larger proportion than the fixt. It unites alſo with earths. It generates leſs heat with water, and leſs cold with ice, than the fixed.—If the reader is deſirous to ſee a more particular account of this ſubſtance, he may conſult *Neumann's* Chemiſtry.

the Mineral Waters that were not poſſeſſed of ſome ſenſible degree of heat. Was any credit to be given to theſe opinions, the Acid of which I am now treating ſhould ſeem, on many accounts, the moſt likely to be found in this manner. On examination, however, of the grounds on which they were founded, there is reaſon to believe, that this, though the poſſibility of it cannot abſolutely be denied, happens in much fewer inſtances than has commonly been imagined. The chief arguments that have been made uſe of in ſupport of the poſſibility of its being found in Mineral Waters, are deduced from the following circumſtances:

1. The univerſality of its preſence through Nature.

It has been the opinion of ſome Chemiſts, that this Acid was generally diſtributed through every part of the natural kingdom; that it was plentifully diſperſed through the ſubterraneous regions, and even preſent in the atmoſphere.

Was this fully aſcertained, it would undoubtedly be a ſtrong argument in favour of this opinion. The proofs, however, are, ſome of them, very equivocal. The chief are the following:

It has been alledged, that the fixt vegetable alkali, expoſed to the air, melts per deliquium, and cryſtallizes again into a ſalt, reſembling vitriolate tartar. But there are no proofs of its actually being ſo, and vitriolate tartar and vegetable alkali cryſtallize in the ſame form. It has likewiſe been urged, in favour of this opinion, that ſilks expoſed to the air have their colour changed, and metals ruſt, and are corroded; but neutral and alkaline ſalts corrode theſe as well as acids, and it is not impoſſible that a neutral ſalt may ſuffer a * decompoſition by the joint action of the ſilks, or metals, and the air. Though this be no more than conjecture, it is uſeful to prevent our forming raſh concluſions, by pointing out the poſſibility of a fallacy in

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* By decompoſition is meant the reſolution (or ſeparation of the component parts) of a compound. Thus Nitre, for inſtance, which is a ſaline body, compoſed of the nitrous acid, and a vegetable alkali, is decompoſed by the addition of the fixed vitriolic acid, which attracts the vegetable alkali more powerfully than the nitrous acid does, and thereby ſeparates it from the nitrous acid.

ſuch caſes. It muſt, nevertheleſs, be owned, that there is one very ſtrong inſtance of its univerſality, viz. its being conſtantly preſent in the electrical fluid, which is generally diffuſed over Nature. This is evident from the ſulphureous ſmell, which is always perceived during electrical experiments, and is the odour of the volatile vitriolic acid. Moreover, if the wire be brought from the gun-barrel to a perſon's tongue, who ſtands on a cake of reſin, it gives no ſhock, but has an evidently acid taſte.

The conical flame, likewiſe, which iſſues from the barrel, when brought within a certain diſtance, has the ſame effect with acids on the vegetable blues.

The ſuppoſition of its exiſtence in the air, has procured it a name by which it is frequently diſtinguiſhed, *Sal acidum vagum univerſale*. On this account the vitriolic acid has been ſuppoſed floating in the bowels of the earth, and not without great appearance of reaſon, becauſe of the quantity that exiſts there, as is univerſally acknowledged, in a compound ſtate; and that many of the ſubſtances that contain it are liable to decompoſition, in which caſe it would be volatile. The deleterious vapours in mines, which are ſaid to hurt or deſtroy animal life, in the ſame way with the vitriolic acid, have been brought in confirmation of this argument.

In anſwer to this, however, it may be alledged, that there are ſo many bodies in the bowels of the earth that it attracts, that it could not remain permanently in form of a vapour, as, on being decompoſed, it would aſſociate with them; that there are other vapours very different from the vitriolic acid, that deſtroy or hurt animal life. The inflammable vapours in mines have been likewiſe brought as another proof; but theſe can only be adduced as inſtances of the vitriolic acid in compoſition, and not even evident proofs of that, as the muriatic acid emits an inflammable vapour likewiſe, during the diſſolution of iron.

It is, however, ſaid, that there are actual proofs of the exiſtence of this acid in ſome Waters, as is manifeſt by their pungent, acid taſte, and by their changing the colour of the vegetable blues. Though theſe facts ſeem to conclude ſtrongly in favour of the opinion of the exiſtence of this acid, yet I cannot, nevertheleſs, think them quite ſatisfactory.

Some compound ſalts, as alum, change vegetable blues to red; and fixed air, when accumulated in large quantity in water, gives it a degree of pungency not eaſily diſtinguiſhable from an acid. It is likewiſe confidently alledged of the laſt-mentioned ſubſtance, that it has the ſame effect with acids on vegetable blues.

Nor does it ſeem at all improbable, that a ſubſtance of the ſame kind with that diſcharged from metals, during their ſolution in acids, which an ingenious Writer ſuppoſes to be their phlogiſton in a ſeparate ſtate, may be contained in ſome Waters. This has not, I own, been yet ſuſpected, though it is evident, from the inflammable damps before-mentioned, that a vapour of this kind diſcharged from iron, is frequently accumulated, in great quantity, in the bowels of the earth; and I ſee no objection againſt the poſſibility of its ſometimes being intermixed and carried along with the current of a ſpring. But as this appears always in form of a vapour, I ſhall treat of it more fully when I come to ſpeak of *Aërial Bodies*.

An ingenious Author has given us great reaſon to think, that the Phlogiſton itſelf is not a ſimple ſubſtance, but a compound of an acid and fixible air. If this theory be juſt, it will eaſily account for the ſimilarity of effects between this ſubſtance and the Vitriolic Acid. If experiments are to be truſted to, the ſame effects are in ſome degree attributed to it. I ſhall ſpeak more largely of this ſubſtance when I come to treat of *Aërial Bodies*.

Notwithſtanding what has been ſaid, and though I am fully ſatisfied that this Acid has frequently been miſtaken for ſome other ſubſtance, I dare not aſſert that this is always the caſe. We have accounts from the beſt authority, of Mineral Waters which ſhewed ſuch evident marks of acidity* as to remove all doubts on this head concerning that quality.

In ſupport of this opinion likewiſe, a plauſible theory has been alledged. It is well known that Pyrites, and even ſulphur* itſelf, eſpecially when they are moiſtened, are liable to deliqueſcence and decompoſition. This might eaſily happen in the bowels of the earth, by the current of a ſtream interfering with any beds of theſe ſubſtances; and if this decompoſition ſhould take place not far diſtant from the ſurface, it might impregnate the ſpring before it be prevented by any freſh attraction.

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* Varenius mentions a fountain in the Province of Nota, in Sicily, which was uſed inſtead of Vinegar. *Monro on Mineral Waters*, vol. i. page 16.

This theory, however, is liable to ſeveral objections.

It is found in general, that neither Pyrites nor Sulphur ſuffer any ſpontaneous decompoſition, except in circumſtances where the air has acceſs, which could not often be the caſe in the bowels of the earth.

This happens very rarely, except in conſequence of ſome large ſubterraneous caverns, where coal, or metal have been dug, and where the air has a communication by which it may be carried off; being, when ſeparated from the ſulphur, in a volatile ſtate. Therefore in this inſtance it cannot be properly eſteemed a pure foſſile.

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* This may be illuſtrated by a familiar inſtance. Flowers of ſulphur are well known to contract by keeping an acidulous taſte, owing to the phlogiſton in part flying off *per ſe*, and leaving the acid ſeparate; and for this reaſon the London College directs them to be waſhed in warm water before they are uſed, in order to clear them of their ſuperabundant acid.

This argument, though it carries ſome weight with it, cannot be admitted to conclude ſatisfactorily againſt what has been urged. That this ſometimes happens in the forementioned caſes, is eaſily granted; but we muſt, on the other hand, allow, that very large * fiſſures of the earth, and ſubterraneous caverns, are not always artificial, but ſometimes formed by nature, and very frequently by thoſe accidents, which, though, as has been before ſaid, are interruptions of its courſe, ſtill make a part of Natural Hiſtory.

Of this kind are earthquakes, volcanoes, ſubterraneous fires, *&c.* which we know by experience, frequently have this effect.

Thus the ground in the neighbourhood of ſeveral volcanoes is found to be hollow

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[*] Dr. Monro, on this ſubject, quotes *Dominicus Vandellius de thermis Agri Patavini*, pag. 95. who relates an account of the native vitriolic acid falling by drops in a native cavern near Latera.

to a conſiderable diſtance, and probably it is owing to this circumſtance, that the waters in the neighbourhood of theſe often poſſeſs this quality in a high degree.

It is probable, likewiſe, as an ingenious Author has ſuggeſted, that in caſes where the fore-mentioned circumſtances occur, "*that the ſubterraneous fire, in decom-"poſing the ſulphureous Mineral Bodies "by which it is principally fed, diſen-"gages a large portion of the Vitriolic "Acid in the neighbourhood of theſe "fountains, which may afterwards inter-"fere, and unite with their current."

This is undoubtedly another poſſible method by which we may account for the preſence of this ſubſtance in Mineral Waters. This, however, happens in fewer inſtances than might be expected, as the attractions of this ſubſtance are ſo general and ſo potent, as to prevent its remaining long unaſſociated, except in ſome† peculiar circumſtances.

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* *Monro on Mineral Waters.*

† Some have imagined chalybeate waters might be impregnated with an acid, in the interval of its ſeparation from the iron, and its diſſipation in the air.

On the whole, then, though with ſome reſtrictions, it muſt be allowed, that the Vitriolic Acid *per ſe*[*] may ſometimes make a part of the impregnations of Mineral Waters[†].

NITROUS ACID.

Nitrous Acid.

The next ſubſtance that occurs in order, is the Nitrous Acid[‡]. The Natural Hiſtory of this is not ſo well aſcertained as that of the Vitriolic Acid, ſo that I cannot ſpeak of it ſo fully. The generality of later Chemiſts have been agreed, that this is never in its ſimple ſtate a native ſubſtance. Its proper matrix ſeems to be the upper part of the ſoil, or ſtaple of the earth, where vegetables grow, and where it is depoſited in great quantity, but always in a compound ſtate, united with an Alkaline Salt. It has not been found, even in this ſtate, in any foſſil ſubſtance, as we cannot reckon Nitre as ſuch. For ſome accounts of the latter being found in trifling quantity at a conſiderable depth in the earth, prove no more than that it is ſometimes waſhed down from the ſurface*. Nevertheleſs, an ingenious Writer of the present

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[*] Although I am inclined to believe, that the vitriolic acid, when found native *per ſe*, is never in a perfectly fixed ſtate, yet it certainly poſſeſſes various degrees of volatility, as is evident by its ſometimes changing the colour of vegetable blues to a reddiſh caſt; whereas, when this acid is perfectly volatile, it deſtroys all colour whatever.

[†] I have been informed, by the learned Dr. Wall, that he had ſome reaſon to ſuſpect an impregnation of this kind in Malvern Water.

[‡] The nitrous acid is more powerful, and may be obtained in a more concentrated ſtate, than any of the other acids excepting the vitriolic. Its ſpecific gravity, when moſt concentrated, is to water as 15 to 10. In the ſtate we generally ſee it, it is of a reddiſh brown colour, and emits a ſtrong fume, or vapour, though it loſes this latter quality, in a great meaſure, on re-diſtillation with water, and when pure, is perfectly colourleſs, and tranſparent. It unites with all the acids, and generates heat with them. Its union with the marine produces a compound, called *Aqua Regia*. It joins the alkaline ſalts with the ſame general phænomena as the vitriolic acid does; but more of it is requiſite to ſaturate a given quantity of alkali, than of the vitriolic. It attracts the alkali more ſtrongly than either of the two following acids. It unites with oils of all kinds, effervеſces, and ſtrikes a black colour with them. It likewiſe generates more heat with them than the vitriolic does, and this is ſo great as ſometimes to produce inflammation. It generates heat, fumes, and efferveſcence with ardent ſpirits, but never breaks out into actual flame. There is a kind of

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Æther produced by this combination. It does not act on ſulphur. It unites with all the metals except gold. It diſſolves and ſuſpends all but antimony and tin, which are only corroded by it. It unites with all the abſorbent earths, and produces with them earthy ſalts. It generates heat with water, but not in ſo great a degree as the vitriolic acid, but produces more cold with ice or ſnow. It attracts water alſo from the atmoſphere, but not ſo powerfully as the vitriolic acid. It inflames on the contact of burning charcoal, and is attended with detonation and exploſion, and is thus the foundation of gunpowder.

* The *ſaline neutral* ſeems to be the only one of the ſix forms of bodies, to which it is united by nature.

preſent age has mentioned the nitrous acid *per ſe*, as the predominant impregnation in moſt of the waters he examined. I would willingly pay all due deference to the authority and judgment of this learned Gentleman, but as he has not recited the methods he took in detecting and aſcertaining this ſubſtance, cannot help ſuſpecting it to be either a miſtake of this for the volatile vitriolic acid, which, in ſome reſpects, ſuch as its decompoſition by the fixt vitriolic acid, its exhaling a powerful odour, *&c.* much reſembles the nitrous, or elſe the decompoſition of ſome ſubſtance uſed in the experiment, containing the nitrous acid.

The late ingenious Profeſſor of Chemiſtry at Edinburgh has made many experiments to this purpoſe, but could never diſcover the leaſt trace of any impregnation of this kind. In order to aſcertain this, I have likewiſe myſelf added a fixt vegetable alkaline ſalt to a great number of pump waters, but never could diſcover the ſmalleſt particle of nitre on evaporation, which muſt have been the caſe

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had the water contained the nitrous acid in ſubſtance.

It would not, however, be proper to deny, from any reaſoning *à priori*, the exiſtence of a fact ſupported by ſo great an authority as the author of the foregoing obſervation. It will not, however, I hope, be eſteemed preſumption, to ſuggeſt a thought, which perhaps may reconcile both theſe opinions. The ſpring water of London, which was the ſubject of the above-mentioned experiments, was, as the author obſerves, liable to many impurities from cellars, burying-grounds, ſewers, and other offenſive places, *&c.* with which they undoubtedly often communicate.

From our accounts of the production of nitre, I ſhould imagine it owed its origin to putrefaction, as it is ſaid to be gained in largeſt quantity by a lixiviation of thoſe earths, which have had the greateſt proportion of animal or vegetable ſubſtances left to putrefy in them.

Since the introduction of the manufactory of Nitre into Europe, the ſubſtance procured on waſhing the earth is found to be a [*] nitrous ammoniac, or the nitrous acid combined with a volatile alkali, which is changed into Nitre by lixiviating it with pot aſhes. This ſeems very probable, as the volatile alkali is always copiouſly gene-

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[*] That there ſhould be ſo great a difference between the operation of nature in the Eaſt Indies and Europe, as that a common Nitre ſhould be produced in the one, and in the other a nitrous ammoniac, ſeems very extraordinary. But the accounts that we have hitherto received of the making of Nitre in Aſia are from inaccurate and injudicious obſervers, ſo that we may readily ſuppoſe them imperfect. The late ingenious Profeſſor of Chemiſtry at Edinburgh mentioned a fact, the probability of which inclined him to form an opinion that cleared up all the difficulties on this ſubject. It is this: That in Aſia they burn a number of vegetables on the place where they want to produce Nitre, and leave their aſhes to have their alkali waſhed in by the rains, which will infallibly decompoſe the nitrous ammoniac, and form a Nitre in the earth which will now be got by ſimple lixiviation. Is it not extremely probable, that thoſe who have given an account of this matter, have neglected the inflammation of the vegetables, conſidering it as merely deſigned to free the earth from them? Nay, perhaps, the inhabitants may have no other intention. I have been ſince informed by Sir J. Pringle, that in ſome parts of Germany a true Nitre is gained by a ſimple lixiviation of the earth, and this would ſeem to contradict the above opinion. But when we conſider the circumſtances attending the method in which it is procured, this difficulty will, in a great meaſure, be got over. The earth uſed for this purpoſe is made up nearly altogether of the filth and rakings of the town ſtreets, and as wood is the conſtant fuel burnt there, it is probable that conſiderable quantities of the aſhes muſt be thrown out, as we ſee in many ſmall towns in England, and thus intermixed with the earth uſed for the above mentioned purpoſe. This, it is obvious, would ſupply an alkaline baſis of the vegetable kind, and thus with the nitrous acid form a true Nitre.

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rated during putrefaction; but there is no reaſon to think this to be the caſe with the fixt. This is moreover confirmed by a circumſtance, which the Author of the above work afterwards relates, *viz.* that a certain ſpring in the city never fails to yield a portion of volatile alkali on diſtillation, which is always the product of putrefaction, and probably owing to ſome animal ſubſtances, with which it is tainted in its paſſage under ground. From what has been above related it ſeems probable, that ſome of the wells, which this ingenious Gentleman examined, might contain the nitrous ammoniac. If then any fixt alkaline ſubſtance was uſed in making the experiment, this would be decompoſed, a degree of * effervеſcence would take place, and a nitrous ſalt would be left on evaporation, in the ſame manner as if the nitrous acid had been preſent in the water uncombined with any other body. It is poſſible, likewiſe, to ſuppoſe a method, by which a ſpring might be impregnated with the nitrous acid in its ſeparate ſtate. Should any of the ſprings, which contain the nitrous ammoniac, communicate with any other, which, from ſome of the ſubſtances above-mentioned, contained the vitriolic acid in a ſeparate ſtate, a decompoſition would take place, by which the nitrous acid might be diſengaged from the volatile alkali, and thus left by itſelf diffuſed through the water.

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* In this caſe the volatile alkali, when ſeparated from the nitrous acid, being in a cauſtic ſtate, would abſorb part of the fixt air ſeparated from the fixt alkali, on its union with the acid. Nevertheleſs, as the fixt alkali contains fixt air in larger proportion than the volatile, ſome effervеſcence would take place from the ſuperabundant portion.

Here, however, another difficulty occurs; the vitriolic acid is always found, when native, in ſome meaſure in a volatile ſtate, in which it will not decompoſe any neutral ſalt formed by the other acids. To this, however, it may be replied, that the volatile vitriolic acid, on being largely diluted with water, is in part reſtored to its fixt ſtate, which may ſerve to account for this appearance *. There is, indeed, one circumſtance,

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* This ſeems true with reſpect to the volatile vitriolic acid *per ſe*, but will not hold of it when united with iron, as in that caſe it ſeems to be entirely diſſipated on its communication with the atmoſphere. This metal ſeems to poſſeſs a power of rendering even the fixt vitriolic acid in ſome degree volatile, as we ſee in ſolutions of green vitriol, which, on ſtanding expoſed to the air, ſuffer a decompoſition, owing to the acids flying off, which occaſions the precipitation of the iron in a flaky ochrous form.

cumſtance, which would ſeem to argue ſtrongly in favour of the notion of the nitrous acids being ſometimes found in the earth, united with vegetable or animal ſubſtances, in a ſtate of putrefaction, as common garden mold yields it by ſimple diſtillation. Now Nitre, although it fuſes both in open and cloſe veſſels, cannot be decompoſed without the addition of ſome other body. Mr. Pott, of Berlin, has nevertheleſs lately ſhewn, that if a fine ſand be added to the Nitre to keep its parts ſeparate, and prevent its fuſion, that this acid will riſe in diſtillation, and come over pure into the receiver. This was, indeed, an old practice, but it was then thought an elective attraction took place, which Mr. Pott ſhews not to be true. It ſeems, therefore, very probable, that the particles of the ſoil here perform the part of the ſand in the other caſe, in preventing the fuſion of the Nitre, and occaſioning the riſe of the acid*. But the ſtrongeſt reaſon of all to induce us to believe, that the nitrous acid is never found native, is, that the ſmalleſt portion of cubic Nitre was never yet diſcovered in any analyſis of ſprings. As common ſalt is accumulated in ſo large quantity in the earth, it muſt be often changed into cubic Nitre, was the nitrous acid preſent there in its ſeparate ſtate.

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* As Nitre is eaſily decompoſed by the addition of heat, and any body that contains the phlogiſton, it may be thought that this takes place here, as a quantity of inflammable matter is always found in earth in this ſtate. There is reaſon, indeed, to think this does not take place except where the air has acceſs, which would not be the caſe here.

The poſſibility of it, however, can ſcarce be denied, as it is ſupported by ſo good authority. Granting, even the facts were as there repreſented, as the cauſes that produce it are obvious, and the circumſtances in which it happens, accidental, it can ſcarce be properly acounted a native impregnation.

MURIATIC ACID.

Muriatic Acid.

The general opinion of the Chemiſts with reſpect to this acid, has been the ſame as that laſt mentioned, *viz.* that it is never found in the earth native in its ſeparate ſtate. When combined with the foſſil alkali, in form of common alimentary ſalt, it is the moſt frequent impregnation we meet with; but I have not, till lately, met with any Writer who has mentioned this ſubſtance combined, as being preſent in any Mineral Waters. Nevertheleſs, the ingenious Author of the foregoing obſervations of the exiſtence of the nitrous acid alone in ſprings, has made the ſame remark with regard to the muriatic. The ſame objection, however, ſtill ſubſiſts, *viz.* that he has not related the experiments by which he aſcertains the truth of his aſſertion.

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* This acid is leſs powerful, and cannot be got in ſo concentrated a form as either of the two foregoing. Its ſpecific gravity, when moſt ſo, is to water as 12 to 10. It is generally got in a fuming ſtate, but may be deprived of that quality in the ſame manner with the nitrous acid. Its colour, when moſt concentrated, is generally a gold yellow. It unites with the other acids with heat and efferveſcence. It joins an alkali, as they do likewiſe, but requires

It is poſſible, however, to account for this, in the ſame manner as the foregoing. Should any of the ſprings, which, from any of the above-mentioned circumſtances, contain the vitriolic acid uncombined, interfere with any that contained common ſalt, the muriatic acid would be ſet looſe in the ſame manner as the nitrous, in the

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requires more of it for ſaturation. It does not unite with oils or ſulphur, and but imperfectly with ardent ſpirits. It acts on all metalline ſubſtances except gold. Zinc, iron, and copper are diſſolved by it, as likewiſe in ſome circumſtances, mercury and antimony. It only corrodes ſilver, lead, and biſmuth. It unites with abſorbent earths, and with the calcarious forms the combination called Fixed Ammoniac.

preceding inſtances. Indeed it ſeems a great argument againſt the exiſtence of the vitriolic acid in ſubſtance in the earth, that this decompoſition of common ſalt, which is ſo plentifully diſtributed through the ſubterraneous regions, does not oftner occur, ſince this is the firſt inſtance I have heard of.

VEGETABLE ACID.

Vegetable Acid.

All Writers ſeem to be agreed, that this acid*, in any of its forms, either ſimple, or in combination, has never been found a foſſile ſubſtance, and, of conſequence, could never impregnate a Mineral Water. Some have imagined the acid ſalt procurable from amber was of this kind, but experience has ſhewn it to have different properties. It is probable that there are other acids, beſides the four already treated of. We have not, however, the leaſt reaſon to believe that any of them were ever found impregnating a Mineral Water.

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* This is of three kinds, one got by expreſſion from the cells of vegetables, particularly acid fruits, in which it is prepared by nature, as juice of lemons; another got by diſtillation, as the acid of the fir, or pine; and a third, which is the product of the acetous fermentation; and even of this laſt there are two varieties, *viz.* vinegar and tartar. The general properties of the vegetable acid are to unite with all the other acids, as alſo with alkalies, only with leſs effervеſcence. Its force of attracting them is alſo leſs. Its ſpecific gravity differs little from water. It does not unite with ſulphur or oils, though it has, when in a very concentrated ſtate, ſome effect on ardent ſpirits. Of the metals it diſſolves zink, iron, copper, and lead; and extracts an emetic quality from antimony. It diſſolves ſeveral of the other metals alſo, when previouſly diſſolved in other acids, and precipitated by an alkali, and ſome of them are rendered ſoluble in it by calcination, and others by mere trituration, as mercury. It unites with abſorbent earths, and, when highly concentrated, generates ſome degree of heat with water. It abſorbs no moiſture from the atmoſphere, as the others do.

ALKALIES.

alies. Having finiſhed what I had to ſay on the firſt diviſion of ſimple ſaline bodies, I ſhall now proceed to the ſecond, *viz*. Alkalies*.

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* An alkali (beſides the properties common to ſaline bodies) in the ſtate we generally ſee it, effervesſces when joined to an acid, that is, we perceive an inteſtine motion excited, attended with many air bubbles, and a hiſſing noiſe. It has moreover the property of changing the vegetable blues green. The property of effervesſcence is not eſſential to alkalies, but owing to their union with a ſubſtance called fixible or mephitic air, and when deprived of this, they loſe that quality. Alkalies are of two kinds:

I. Fixed.
II. Volatile.

The fixt alkali comprehends two ſpecies, the

1. Vegetable.
2. Foſſile.

The volatile alkali contains one ſpecies only.

The properties common to both ſpecies of fixt alkalies are, that they cannot be diſſipated but by the moſt extreme heat, and that they emit no odour when applied to the noſtrils.

The volatile alkali is diſſipated by the ſlighteſt degree of heat, and emits a remarkable pungent odour.

In treating of theſe I cannot follow the order before laid down with reſpect to the Acids, to take them in their order of ſtrength, as it is not yet determined whether the vegetable or the foſſil alkali have the ſtrongeſt attraction to acids. As, however, the natural hiſtory of the vegetable alkali is beſt known, I ſhall begin with that, and proceed, in order, to the foſſil and the volatile alkali, which laſt is the weakeſt of any.

FIXT VEGETABLE ALKALI *.

Fixt Vegetable Alkali.

The vegetable fixt alkali does not appear to be a native ſubſtance, either in its

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* The Vegetable Alkali has a pecular taſte, more or leſs acrid as it is more or leſs cauſtic. It is often deſcribed as of an urinous flavour, or that of the volatile alkali. This, however, does not proceed from it, but from an ammoniacal ſalt contained in the ſaliva, which is decompoſed by it. When pure, it is of a ſnow white colour, and perfectly inodorous. It concretes, when perfectly mild, into regular cryſtals, of an hexagonal priſmatic form, terminating in a pyramid at both ends. When in the ſmalleſt degree cauſtic, it attracts moiſture from the air, and runs per deliquium. It will not unite with the foſſil alkali, though the one ſo much reſembles the other. It joins all the acids, and forms,

with

pure ſtate, or as united with other bodies. It was formerly thought to be preſent in vegetables, from whence ſome have inferred the poſſibility of its being a foſſil ſubſtance. In proof of this ſome facts have been alledged, but theſe are far from being concluſive, as it never appears in them before inflammation, during which, in any vegetable ſubſtance, it is always copiouſly

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with each of them, neutral ſalts. It attracts acids more ſtrongly than the volatile alkali, metals, or earths. Both this and the foſſil alkali ſeem to have nearly the ſame force of attraction. It unites with oils of all kinds, and, with them, forms different ſoaps; but this union ſeems confined to its cauſtic ſtate, in which, alſo, it will unite with ardent ſpirits. It unites with ſulphur, and forms with it a compound ſoluble in water, called hepar ſulphuris. It diſſolves copper, lead, and iron in their metallic ſtate, and acts on all the reſt, when precipitated from their acid menſtruums. It promotes their fuſion greatly, and unites alſo with them in this way. It diſſolves ſome of the animal earths, as the calculus of urine, and in fuſion joins all the pure earths, and, when ſo united, forms glaſs. It generates heat with water when cauſtic, and the more that quality predominates, the greater is the heat. In this ſtate, likewiſe, it diſſolves univerſally animal and vegetable ſubſtances. When mild, and in a cryſtallized form, it produces cold. By long boiling it is altered in its nature, part of it being converted into an abſorbent earth. It checks fermentions of all kinds, and is, therefore, antiſeptic.

generated. From what has been above ſaid, it ſhould ſeem, that we can never expect to meet with this ſubſtance preſent in any Mineral Water; and, indeed, all facts ſeem univerſally to confirm this opinion, as no Author has aſſerted that it has been ever found in its ſeparate ſtate in any Mineral Water. There have been, indeed, ſome ſuſpicions that it ſometimes appears there in a compound ſtate, which I ſhall ſpeak of when I come to treat of Compound Saline Bodies.

Dr. Percival has, indeed, very ingeniouſly ſuggeſted to me, that the vegetable alkali may ſometimes be waſhed down in ſufficient quantity to impregnate a running water. If we give credit to the accounts of large woods being ſet on fire by lightning, and burnt down, any ſpring riſing near them might thus receive their aſhes, as waſhed down into it by the rains; which aſhes, as was before ſaid, contained the vegetable alkali very copiouſly; the poſſibility of the fact cannot be denied; and it muſt be likewiſe owned, that though it is, in ſome degree, accidental, yet the circumſtance producing it happens in the courſe of nature, ſo that we cannot deny it to be a native impregnation. It does not, however, as has been before obſerved, appear from any accounts, that we have any facts to prove that this has ever happened; and, indeed, I am inclined to believe, that if it were to take place, it could be only temporary, and, moreover, deſtitute of that equal degree of impregnation at all times, which ſo eminently characteriſe the generality of the native Mineral Waters.

FOSSILE ALKALI.

Foſſile Alkali.

* It was the opinion of the antient Chemiſts, that Mineral Waters were always

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* The foſſile alkali agrees nearly with the vegetable in the ſenſible qualities of taſte, colour, and odour, but varies greatly in regard to its conſiſtence; aſſuming a ſolid form with great eaſe, and ſo far from attracting moiſture from the air, that it becomes drier, and has its cryſtals covered with a mealy powder. It unites with acids with leſs efferveſ-

cence

impregnated with an acid, either in its ſeparate ſtate, or in combination with other bodies: But Drs. Stahl and Hoffman have ſince ſhewn, that they ſometimes contain the foſſile alkali, unmixed with any other ſubſtance. That it exiſts in large quantity in the earth, is well known from the quantity of native ſaline ſubſtances that contain it, the foſſile alkali forming the alkaline baſis of Glauber's ſalt, and common ſalt, both which, (the latter, indeed, more particularly,) we know to be native foſſile ſubſtances. I have likewiſe been informed, by ſeveral accurate and judicious obſervers, in particular the learned Doctor Wall, of Worceſter, that this ſubſtance, in its ſeparate ſtate, has been diſcovered in ſeveral Waters in Great Britain *.

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cence than the vegetable, and forms different neutrals. Its force of attraction, and effects on other bodies, ſeem exactly the ſame, ſo that it forms a ſoap with oils, hepar ſulphuris with ſulphur, glaſs with earths, *&c.*

* It is proper to obſerve, that the foſſile alkali, when native, is always in a mild ſtate, though it is capable of being rendered cauſtic, in the ſame manner as the vegetable.

VOLATILE ALKALI.

Volatile Alkali.

It has been a great matter of diſpute, if ever the foſſile kingdom affords this ſubſtance native *. Some circumſtances would lead us to favour ſuch an opinion. Many ſtones have been found, which, when broken, and the inner parts rubbed ſtrongly againſt each other, give out an odour reſembling the volatile alkali, from whence their name has been taken, *viz. Lapis Suillus.*

It is likewiſe undoubtedly found in ſome plants, particularly thoſe of the acrid kind.

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* This ſubſtance differs in appearance, as it is mild or cauſtic, being in the firſt caſe eaſily cryſtallized, but in the ſecond, always in a fluid form, becauſe (on account of its volatility, which is much greater when cauſtic) it cannot be rendered ſolid by force of fire. It forms different neutrals with all the acids. It does not unite with oils when mild, and very imperfectly when cauſtic, nor with ardent ſpirits. With ſulphur it forms a hepar ſulphuris; it unites with ſuch metals as the fixed alkali does, both in ſolution and precipitation. With copper, or its ſolution, it ſtrikes a beautiful blue colour. It does not unite with earths in the way of fuſion, probably on account of its volatility, but diſſolves the calculus of urine. When mild, it generates cold with water, and when cauſtic, heat.

It was formerly thought it was not diſcoverable in them before a degree of putrefaction had begun to take place, but though it is then greatly increaſed, as it is always copiouſly generated during that proceſs, there is reaſon to believe, that it exiſted in the plant before that began to take place. From hence it has been inferred, that it is ſometimes of foſſile production. The former of theſe circumſtances, indeed, ſeem to argue ſtrongly in favour of that opinion. The ingenious Profeſſor at Edinburgh, nevertheleſs, accounts for this from ſome vegetable or animal ſubſtances being waſhed down in a ſtate of putrefaction, and theſe concretions forming round them. Whether this opinion be juſt, or no, is of ſmall conſequence to the preſent queſtion, as it is always here in a ſtate of too firm concretion to be waſhed out by water, and therefore could never by theſe means impregnate a ſpring.

As to its being found in vegetables, it is probably formed there by ſome peculiar proceſs during vegetation, and not abſorbed from the earth; though even granting that it were ſo, it could only be in conſequence of the putrefactive proceſs, which is conſtantly going forward in the upper part of the earth where vegetables grow, and which never deſcends ſo deep as to be capable of impregnating a running water with any ſubſtance produced in conſequence of it.

In great cities, indeed, where large quantities of putrefying ſubſtances are neceſſarily accumulated, and the ſewers placed at a conſiderable depth in the earth, it is not improbable that they may often interfere with the current of ſprings, and impart to them ſome degree of a volatile alkaline impregnation.

An inſtance of this was above related, as mentioned by Dr. Heberden.

As, however, the circumſtances in which this happens cannot fairly be aſcribed to Nature, it cannot, in this inſtance, be accounted a native impregnation.

There is, however, one circumſtance which ſeems to ſupport the poſſibility of its being ſo.

Sal ammoniac has been ſometimes found a foſſile ſubſtance, as adhering to the lava of volcanoes, where it is produced by inflammation, during which it is often copiouſly generated.

It has been found ſometimes likewiſe in this country in fiſſures of the earth, from whence the ſmoak of burning coal pits iſſues. Should this be again waſhed down into the earth, and interfere with any ſpring containing the foſſile alkali, a decompoſition would enſue, a common ſalt would be formed, and the volatile alkali left by itſelf combined with the water.

This caſe is certainly poſſible, but I have ſeen no experiments adduced in proof of it.

Henckel, indeed, in his *Betheſda Portuoſa*, tells us, that he found a volatile alkali in ſeveral waters on diſtillation, but in his experiments he formed an hepar ſulphuris, and the fixed alkali, when decompoſed from thence, appears in a volatile form.

As hepar ſulphuris is ſo commonly found a foſſile ſubſtance, were we certain of the preſence of an unneutralized acid in the bowels of the earth, there would then be leſs doubts concerning the poſſibility of this impregnation, as the hepar ſulphuris is decompoſed by every acid, and the ſaline compound formed in conſequence of it, might be again decompoſed by the foſſile alkali, as in the manner before related.

This, however, is but barely poſſible, and withal requires ſuch a combination of circumſtances as we can ſcarce expect to occur in the ſame inſtance.

In a word, though the poſſibility of the volatile alkali making a part of the impregnation of Mineral Waters cannot be abſolutely denied from any reaſoning *a priori*, yet for the reaſons before given, and as its exiſtence there is not ſupported by any facts, it can ſcarce be accounted a native impregnation of Mineral Waters.

SECT. II.

Of MINERAL WATERS *impregnated with* COMPOUND SALINE SUBSTANCES.

HAVING finiſhed what I had to ſay of ſimple ſaline ſubſtances, I now proceed to the compound *.

And here the Reader is again deſired to take notice, that I mean to confine this term, which is often uſed in a larger ſignification, to the neutral ſalts only, as the metallic and earthy ſhall be treated of ſeparately, when I come to ſpeak of metallic and earthy ſubſtances.

I ſhall take theſe in the order † they ſtand in the annexed table; the firſt of theſe that occurs is vitriolate tartar.

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* Compound ſaline bodies are formed by the union of the firſt ſimple ſaline body, *viz.* an acid with ſuch ſubſtances as by that union produce a third body, which poſſeſſes the characteriſtics of the ſaline claſs; theſe are either the other ſimple ſaline ſubſtance, *viz.* an alkali, or elſe metallic, or earthy bodies, ſo that compound ſaline bodies are of three kinds, *viz.*

I. Neutral, compoſed of an acid and an alkali.

II. Metallic, of an acid and a metal, generally, though other ſaline ſubſtances are capable of reducing them into a ſaline ſtate.

III. Earthy, of an acid and an earth.

† It has been before obſerved, that a neutral ſalt was formed by the combination of the two ſimple ſalts, *viz.* an acid

VITRIOLATE TARTAR*.

Vitriolate Tartar.

This compound ſalt is generally imagined not to be a native ſubſtance. It is ſaid to

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acid with an alkali, which can be only united together in certain proportions. As there are four of the former of theſe, and three of the latter, it is evident that theſe can only be formed into twelve combinations; the different names of theſe are ſet down in the enſuing table. In the firſt column are placed the four acids, oppoſite each of theſe the three alkalies, and thirdly, three ſets of ſalts oppoſed to each acid.

A TABLE *of* NEUTRAL SALTS.

Acid.	Alkali		
I. Vitriolic.	fixt	Vegetable	Vitriolate Tartar.
		Foſſile	Glauber's Salt.
	Volatile		Vitriolic Ammoniac.
II. Nitrous.	Fixt	Vegetable	Common Nitre.
		Foſſile	Cubic Nitre.
	Volatile		Nitrous Ammoniac.
III. Muriatic.	Fixt	Vegetable	Digeſtive Salt.
		Foſſile	Common Salt.
	Volatile		Common Ammoniac.
IV. Vegetable.	Fixt	Vegetable	Sal Diureticus, vel Tartarus regeneratus.
		Foſſile	Sal Polychreſtum Rupellenſe.
	Volatile		Vegetable Ammoniac, or Sp. Myndereri.

* Vitriolate tartar, when carefully cryſtallized, aſſumes the form of ſix ſided pyramids in its cryſtals, which are of an hard concretion, and more difficult ſolution than any neutral ſalt we are acquainted with, requiring near thirty times its weight of water, to render it fluid in the common temperature of our atmoſphere. It is of ſo difficult fuſibility, that in our furnaces we are not able to fuſe it. When heated to a certain degree, it decrepitates, that is, makes

be found, indeed, in the aſhes of ſome plants, but is there probably produced by

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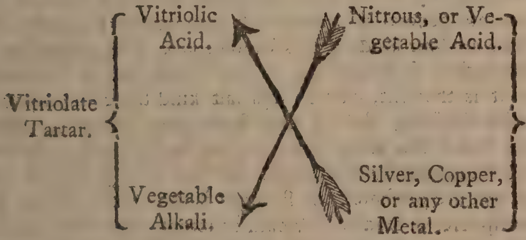
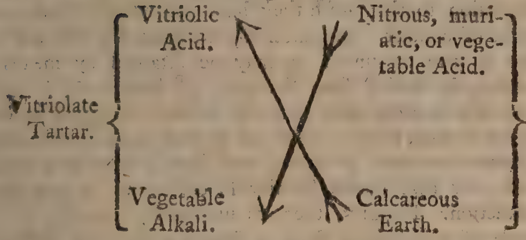
makes a crackling noiſe in conſequence of the rarefaction of the water contained in its cryſtals. It may be decompoſed by addition of the phlogiſton, which forms with it an hepar ſulphuris, by adding ſolutions of calcareous earth, magneſia, or any of the metals, in any of the other acids. In the three laſt mentioned caſes, however, a double elective attraction always takes place, as in the annexed ſchemes.

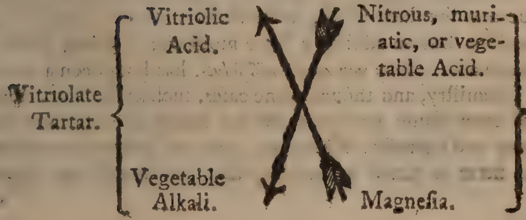
CASE I.


Vitriolic Acid.
Nitrous, or Vegetable Acid.
Vitriolate Tartar.
Vegetable Alkali.
Silver, Copper, or any other Metal.

CASE II.



CASE III.



the inflammation. This fact, however, is much to be doubted, as the vegetable

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As the term *Elective Attraction* will frequently occur in the courſe of the work, and as it is here uſed in a peculiar ſenſe, the Author has ſubjoined the following explanation of it.

The combination of bodies depends on that inclination or tendency which they have to approach to each other, and, in certain circumſtances, to remain coherent. To this general fact, the Engliſh Philoſophers have given the name of Attraction. This, however, is not meant to expreſs a primary principle, but as Sir Iſaac Newton, who firſt brought the term into general uſe, employed it to expreſs a general fact. There are four kinds of this known, *viz.* The Attraction of Gravitation, of Magnetiſm, of Electricity, and of Coheſion; and it is thought, that on this laſt kind the combination of bodies depends, though that ſeems very doubtful. However, before this takes place, the two bodies muſt be ſo near, as to be apparently in contact, and the more points of contact that are preſented the ſtronger is the union. Thus two hemiſpheres of lead will remain coherent on preſſing together their plain ſurfaces, and their union will be the ſtronger in proportion to the poliſh they have got, which affords more points of contact. But, after all, the greateſt poliſh will not give ſo firm an union as may be attained by means of fluidity, in which ſtate the parts of bodies are ſo eaſily moveable on each other, as to run into and fill up the hollows on the ſurface, ſo as to afford the greateſt quantity of contact. It ſeems, however, probable, that there is ſomething beſides contiguity that makes fluidity ſo efficacious in promoting Attraction. Fluidity, then, is univerſally neceſſary to the union of two bodies, ſo as to form a mixt. For inſtance; if we join two inodorous powders together, *viz.* ſal ammoniac and the fixed alkali, while theſe continue dry no change happens, but on adding a little moiſture, a ſtrong odour is perceivable. *Sales non agunt niſi ſoluti*, has long been a maxim in Chemiſtry, and though ſome caſes, ſuch as the heat, fumes, and even flame produced by the union of regulus of antimony and corroſive ſublimate, ſeem to prove the contrary, yet there is reaſon to believe, that this would not happen

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alkali and vitriolate tartar cryſtallize in the ſame form, which might give occa-

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was not a quantity of moiſture abſorbed from the air. This, however, may be laid down, that fluidity in one of the bodies is neceſſary for combination. The ſame degree of Attraction, however, does not ſubſiſt between all bodies; there are ſome which refuſe to combine with one, and yet unite with another. Thus water unites with nitre but not with camphor; and ſpirits of wine unite with camphor and not with nitre. This is what is called *Elective Attraction*, and is either abſolute, as in theſe two caſes, or relative, when a body unites with another, but will leave it if a third be preſented, becauſe there is a ſtronger attraction between this new body and it. Thus ſilver and gold may be united together; but if the nitrous acid be preſented, the ſilver joins it, and leaves the gold. Elective attractions may be alſo conſidered as either ſingle or double. There is always a new combination takes place in elective attraction, and when there is but one, this is called *ſingle*, that is, when a ſingle or ſimple body is uſed to make the ſeparation. But when a body, which is itſelf compoſed of two others, is uſed to ſeparate two bodies; two ſeparations, and in general two new combinations happen. Thus, if the muriatic acid, united to mercury be uſed to ſeparate the nitrous acid and ſilver, the nitrous acid leaves the ſilver, and joins the mercury, and at the ſame time the muriatic acid unites with the ſilver. It ſometimes happens that a ſeparation may be effected by means of a double Elective Attraction, which could not be produced by a ſingle. Thus if the vitriolic acid be joined to a fixed alkali, they have a greater affinity, or ſtronger attraction to each other, than any ſingle body has to either of them. But if the ſolution of ſilver in the nitrous acid be preſented to them, the ſilver attracts the vitriolic acid, and the nitrous acid and the vegetable alkali attract each other, and theſe two forces acting in oppoſite directions, overcome the union of the vitriolic acid and vegetable alkali, and ſeparate them. Thus if, as in the annexed ſcheme, ſuppoſing the attraction between the vitriolic acid and the vegetable alkali be ſuppoſed to be as twenty-five, and that between the nitrous ſion to the miſtake of them for one another. Whether this be ſo or not, there

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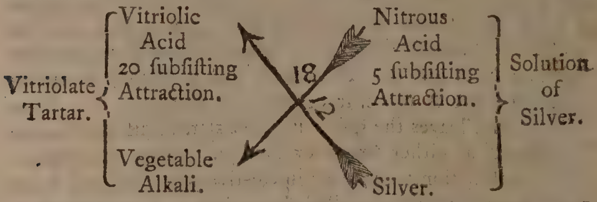
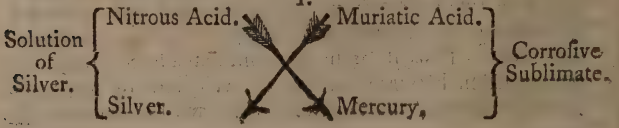
nitrous acid and the ſilver to be as five; the compound of theſe, *viz.* twenty five, may be conſidered as the power that keeps them in their preſent ſituation. But if the attraction between the nitrous acid and the vegetable alkali be as eighteen, and that between the vitriolic acid and ſilver be as twelve, the aggregate of theſe will be thirty, which is ſuperior to the former, and muſt of conſequence work a ſeparation which neither of the two ſubſtances ſingly would have effected.


Vitriolate Tartar.
Vitriolic Acid 20 ſubſiſting Attraction.
Vegetable Alkali.
18
12
Nitrous Acid 5 ſubſiſting Attraction.
Silver.
Solution of Silver.

The darts are meant to expreſs the ſtronger attraction of the body from whence the feather proceeds, to that to which the point is directed, than the body with which it was then joined. Thus, in the above caſe, the ſilver attracts the vitriolic acid ſtronger than it does the nitrous, with which it was united; and the nitrous attracts the vegetable alkali ſtronger than it does ſilver. In this caſe the poſition of the darts could not be altered, as, were the points placed in a direction from the vitriolic acid to the ſilver, and from the vegetable alkali to the nitrous acid, it would denote, that the vitriolic acid attracted ſilver ſtronger than the fixt alkali; and that the alkali attracted the nitrous acid ſtronger than it did the vitriolic, which is not true. In ſome caſes, the poſition of the darts may be varied, as thus:

I.



II. Niis not the leaſt reaſon to think, either from our accounts of facts or theory, that this

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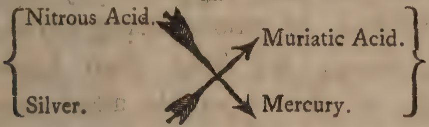
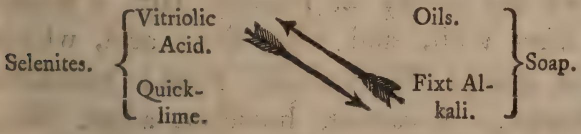
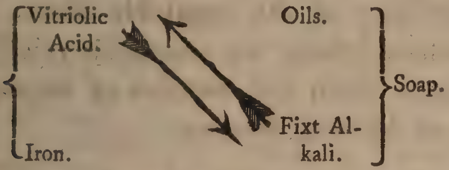
II.



This may be further varied; but this is ſufficient. In ſome caſes of decompoſition of compound ſubſtances by compound ones, only one new compound is formed. This is the caſe in the curdling of ſoap, ſo frequently obſerved in our ſpring waters. In this caſe the darts are put ſide by ſide. Thus:



Here the calcareous earth or quick-lime does not unite with the oil. The ſame thing happens in chalybeates. Thus:



In forming ſchemes of this kind on paper, we ſhould be careful to place the ſolvent body uppermoſt. In general, where we can place the darts with both their points either upwards or downwards, we may be pretty certain that a decompoſition will take place, but where they can only be placed laterally, or ſide by ſide, (the laſt caſe eſpecially,) it is more uncertain. In many caſes where the darts are placed either upwards or downwards, they may be likewiſe placed laterally; but the converſe does not hold, as ſome was ever found a native foſſile, ſince one of its component parts, the vegetable alkali, is confeſſedly an artificial ſubſtance. If, however, the fact ſuggeſted by Dr. Percival be true, of woods being burnt down by lightning, we may then ſuppoſe it poſſible, as the vegetable alkali might be waſhed down by the rains and impregnate a ſpring, and, as its attraction to the vitriolic acid is ſtronger than any metallic or earthy ſubſtances, it would decompoſe all the earthy or metallic ſalts it might meet with, and with their acid, which is always the vitriolic, form a vitriolate tartar. I cannot, however, admit this, even in theſe circumſtances, to be a native impregnation for the reaſons before given, in ſpeaking of the vegetable alkali. On the whole, then, we may ſafely reject this ſubſtance from the number of impregnations of Mineral Waters.

ſome cannot be varied from their lateral poſition to both the darts upwards, or both downwards, and it is theſe caſes which are here meant. In order to make this more clear, a Table of Elective Attractions, with an Explanation, is added at the end of this Book.

GLAUBER'S SALT*.

Glauber's Salt.

As I have before mentioned that the two compound parts of this ſalt are foſſile ſubſtances, which bear a ſtrong affinity to each other, it is certainly not unreaſonable to ſuppoſe that they may be often found united, in which caſe they would form a Glauber's ſalt. The probability of this will appear ſtronger when we conſider the place the foſſile alkali holds in the Table of Elective Attractions, with reſpect to the vitriolic acid; the latter attracting the foſſile alkali ſtronger than any other native ſubſtance known, the phlogiſton excepted; and even with reſpect to this there are ſome doubts. Experience likewiſe confirms the foregoing theory; and we have undoubted proofs, that this ſalt has been found native in the earth, and, on account of its eaſy ſolution in water, may make an impregnation of a mineral one, and indeed it is in this ſtate it has been generally found.

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* The form of the cryſtals of Glauber's ſalt is that of a ſix ſided priſm. It differs, however, in this reſpect from the foregoing, in that its cryſtals are much larger, and have their ends obtuſely truncated; whereas the others end in a pyramid. They are likewiſe of a very looſe contexture, as containing more water than thoſe of any other neutral ſalt whatever. It is of the eaſieſt and moſt plentiful ſolubility of any neutral ſalt known. It is remarkable to obſerve here the changes that happen to bodies in compoſition. The vitriolic acid, and the vegetable alkali, (in its cauſtic ſtate, in which it always is when it forms a neutral,) attract water ſtrongly when ſeparate, and readily unite with it. Nevertheleſs, theſe two, when combined, form a neutral, (*viz.* vitriolate tartar,) which is of the moſt difficult ſolution of any ſalt of that (neutral) kind. On the other hand, the foſſile alkali, which makes the alkaline baſis of Glauber's ſalt, is not deliqueſcent, (or liquefiable in the air,) and ſeems to have much leſs attraction to water; and yet Glauber's ſalt is of much eaſier ſolution. It fuſes eaſily in the fire, and is ſaid to have ſome great effects upon metals, but theſe are not aſcertained. It can be decompoſed only in the manner in which vitriolate tartar is decompoſed.

Its appearance, however, in the earth is not ſo frequent as has been imagined, another ſubſtance which reſembles it, and which ſhall be mentioned hereafter, having been often miſtaken for it. It is, however, certainly ſometimes a native impregnation of Mineral Waters.

VITRIOLIC AMMONIAC*.

Vitriolic Ammoniac.

From what has been ſaid concerning the volatile alkali's not being a native foſſile ſubſtance, it ſhould ſeem probable, that this likewiſe, which has the volatile alkali for one of its component parts, ſhould be alſo rejected from the catalogue of native impregnations. Experience likewiſe ſeems to favour this opinion; as no Writer, that I know of, has aſſerted, that this ſubſtance has been ever diſcovered in any Mineral Water *.

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* This ſubſtance is eaſily got in hard dry cryſtals, which do not deliqueſce, and are of difficult ſolution in water. It may be formed from various combinations, more, indeed, than any of the other ammoniacal ſalts, as its acid has a ſtronger force of attraction. It may be decompoſed by the fixed alkali, or by forming it into an *hepar ſulphuris*, and and adding any of the other acids to it.

I have, however, ſome doubts if we can ſafely deny the poſſibility of its ſometimes making a part of their impregnation. It has been before obſerved, that ſal ammoniac was produced by inflammation, and that by this means it has been found native in the clefts and fiſſures of the earth in the neighbourhood of volcanoes and ſubterraneous fires. That the vitriolic acid likewiſe had been found native in the neighbouring ſprings, being ſeparated by the force of fire from the pyrites.

Should, therefore, any of the ſprings, thus impregnated, have the ſal ammoniac, formed as above, waſhed down into it, a

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* Hoffman ſeems to hint, that a ſalt of this kind was ſometimes found in the neighbourhood of volcanoes; but his meaning is not very clear. See vol. iii. p. 138. § xxxix.

decompoſition would enſue, the vitriolic acid uniting with the volatile alkali of the ſal ammoniac, and forming with it a vitriolic ammoniac. To this it may be objected, that the vitriolic acid is then in its volatile ſtate, in which it will not decompoſe any of the neutral ſalts.

This objection is in part true, as we have great reaſon to believe, that the vitriolic acid is ſeparated by fire from ſulphur in that ſtate.

We know, however, by experience, that if the communication with the air be obſtructed, which ſeems likely to be the caſe in ſubterraneous fires, it ſoon becomes fixed when diluted with water. A proof that this ſometimes actually happens in theſe caſes is, that theſe ſprings are ſaid to change the vegetable blues to a red, whereas the volatile vitriolic acid diſcharges entirely all vegetable colours whatever. It is not therefore impoſſible, that ſome of the ſprings in the neighbourhood of volcanoes, burning coal-pits, and other ſubterraneous fires, might, if examined, be found containing a portion of this ſubſtance.

As I have not, however, had any opportunity of making the experiment, and as I before acknowledged no Author has mentioned it as actually diſcovered, what has been ſaid above muſt be conſidered only as theory that bears ſome appearance of probability. I cannot, therefore, reject this ſubſtance from the catalogue of poſſible impregnations of Mineral Waters.

We now come to the ſecond arrangement of Neutral Salts, *viz.* thoſe which have the Nitrous Acid in their compoſition. The firſt of theſe that occurs in order is common Nitre.

COMMON NITRE*.

Common Nitre.

I mentioned before, in the account of the Nitrous Acid, that it was never found a native foſſile, either *per ſe*, or in compoſition. Some traces, indeed, of a nitrous ſalt are ſaid to be found in ſome waters; but there is reaſon to believe, that it was accidentally waſhed down from the ſurface, where (in the putrefying ſoil) it is copiouſly generated. On this account, and as its alkaline baſis is always an artificial ſubſtance, it can by no means be admitted as a native impregnation of ſprings.

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* The cryſtals of Nitre neither melt, *per deliquium*, in a moiſt, nor calcine in a dry air. Their form is that of a ſix ſided priſm; and, when very perfect, terminate, at one end, in a pyramid of ſo many ſides. It is of a middle ſolubility, between Glauber's ſalt and Vitriolate tartar; but the different temperature of its menſtruum makes a greater difference in its ſolubility, than any of the neutral ſalts. It is of eaſy fuſion in the fire. By application of the phlogiſton it may be decompoſed without going firſt into the form of an *hepar ſulphuris*. Hale's Experiments ſhew, that it contains much fixed air, which, during its deflagration, is rarified, and explodes with violence; and hence is the foundation of exploding mixtures, particularly gunpowder.

CUBIC NITRE*.

Cubic Nitre.

By what has been before ſaid, concerning the nitrous acid, it appears, that this ſalt can never be found native in Mineral Waters.

No Author that I have met with has ever aſſerted it; though, if the nitrous acid were ever in its ſeparate ſtate in the bowels of the earth, it muſt be frequently formed, as common ſalt is contained, in ſome degree, in every ſpring hitherto diſcovered, and its alkaline baſis bearing a ſtronger affinity with the nitrous acid, than with the muriatic with which it was united, the common ſalt would be decompoſed, and a Cubic Nitre formed in its place.

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* Cubic Nitre agrees nearly altogether with Nitre in its properties, and differs only in the form of its cryſtals, which are, like Nitre, ſix ſided; but theſe ſides are of a rhomboidal figure.

Did this ever happen it would account for the preſence of the muriatic acid alone in ſprings, as aſſerted by ſome Writers, though on ſcarce ſufficient foundation.

As, however, its alkaline baſis is confeſſedly a native ſubſtance, both in its ſeparate ſtate and in compoſition, it ſhould not ſeem unlikely, that Cubic Nitre might be met with in many of the ſprings in great cities, where, by communicating with putrefying bodies, they may have received an impregnation from the nitrous acid or nitrous ammoniac. Impregnations, however, of this kind, as happening only in accidental circumſtances, and being produced by means evidently artificial, cannot be admitted into the catalogue. In conſequence of this, therefore, Cubic Nitre muſt be excluded.

NITROUS AMMONIAC*.

Nitrous Ammoniac.

From what has been before ſaid concerning the nitrous acid and the volatile alkali, the two component parts of this ſalt, we may conclude, that the Nitrous Ammoniac can never, except in circumcumſtances that cannot fairly be aſcribed to Nature, be found native in ſprings. It is, in all probability, never produced except in conſequence of † putrefaction, which was before-mentioned, as not taking place at a ſufficient depth in the earth to impregnate a running water. For a further explanation of this, the Reader may look back to what has been ſaid concerning the Nitrous Acid, the Volatile Alkali, and Nitre.

The next order of Salts is of thoſe which have the muriatic acid in their compoſition, the firſt of which is Digeſtive Salt.

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* The Nitrous Ammoniac aſſumes a leſs ſolid concretion than the Vitriolic, or even common Ammoniac. It is very deliqueſcent, and diſſolves eaſily in ſpirits of wine. Its moſt remarkable property is, that it inflames, and explodes *per ſe*, which ſhews how difficult it is to aſſume a general characteriſtic of bodies, ſince this contradicts that generally given of ſaline ſubſtances.

† Some have imagined, though on no very good grounds, that the Nitrous Ammoniac is ſometimes produced during the inflammation of burning bodies. If this be the caſe, it

DIGESTIVE SALT*.

Digeſtive Salt.

This is eaſily determined not to be a native ſubſtance, the Vegetable Alkali having been before proved not to be found below the ſurface of the earth. Granting, however, that it ſhould be ſo accidentally, as in the caſe before-mentioned, of woods being ſet on fire by lightning, this ſalt could not be formed, as the muriatic acid is never found a native foſſile, except when combined with the foſſil alkali in form of common ſalt, which is not decompoſed by the Vegetable Alkali. It may therefore be ſafely excluded from the catalogue of Impregnations of Mineral Waters.

COMMON SALT†.

Common Salt.

This is well known to be a foſſile ſubſtance, exiſting in great quantity in the

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it might be poſſibly found in ſprings which riſe in the neighbourhood of volcanoes, or ſubterraneous fires, ſuch as were mentioned in ſpeaking of the vitriolic acid.

* This ſubſtance reſembles common ſalt in moſt reſpects. Its cryſtals are cubical, like thoſe of common ſalt, and can be got firm and ſolid much more eaſily. Some Chemiſts have fancied that there was ſome other difference, but their proofs are not ſatisfactory. More will be known of its qualities when we come to ſpeak of common ſalt.

† This is too well known to need much deſcription, ſo ſhall only mention a few of its characteriſtic marks. The form

earth, and ſo common an impregnation of ſprings, that ſcarce any have been diſcovered entirely diveſted of ſome traces of this quality. It is found native in the earth in much larger quantity than any other ſaline body that we know of. It is likewiſe more univerſally diſperſed, though very unequally ſo. In conſequence of this, we meet with many more degrees of this impregnation than of any other ſaline ſubſtance, it being found from quanties imperceptible to the ſenſes, to that of a ſaturated ſolution. In this ſtate it is, I believe, always pure, though in the ſtate we get it, there is almoſt always a ſuperabundant portion of abſorbent earth adhering to it, but this is owing entirely to the heat uſed in the boiling neceſſary for the cryſtallization; part of the acid being diſſipated, and the alkali changed in ſome degree into an abſorbent earth. If the cryſtalli-

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form of its cryſtals, when carefully made, is that of an exact cube. In the fire it decrepitates like vitriolate tartar. It diſſolves in two thirds its weight of water, and in equal quantity, whether the water be cold or hot. It is not ſo fuſible as nitre, or ſo refractory as vitriolate tartar. It may be decompoſed by force of fire, with addition of any inflammable ſubſtance, or, in general, by elective attraction. It is antiſeptic, but in what proportion is unknown.

zation, however, be performed with a moderate degree of heat, and ſtopt in proper time, the ſalt may be got perfectly pure. We may therefore conclude, that it is in this ſtate that it exiſts in ſprings.

SAL AMMONIAC*.

Sal Ammoniac.

It was long thought that this was a native ſubſtance, but this opinion is now found to be erroneous. It has been already mentioned that it was ſometimes found in the neighbourhood of volcanoes, and other ſubterraneous fires, and chiefly in the cracks and fiſſures from whence the ſmoak iſſues; many inſtances of this are to be found in Britain.

In this ſituation, therefore, it might undoubtedly be waſhed down by the rains, and impregnate any ſtream it might meet with. I have, however, before given it as my opinion, that this would not conſtitute a native impregnation; it cannot, therefore, be received into our catalogue as ſuch.

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* The cryſtals of ſal ammoniac are in form of a ſtar. Thoſe that I have ſeen had four points; but ſome have aſſerted, that they have ſix points. It deliqueſces in moiſt air, but readily aſſumes a concrete form. It requires thrice its weight of water to diſſolve it. It diſſolves in alcohol, and fuſes in a gentle heat, in which it riſes entire in flowers, without any decompoſition, for which reaſon it is purified by ſublimation. Its being found native in the neighbourhood of burning mountains, &c. has induced an ingenious Chemiſt to think, that all the acids are convertible by inflammation into the muriatic.

We now come to the laſt arrangement of neutral ſalts, *viz.* of thoſe compounded with the vegetable acid.

REGENERATED TARTAR.

Regenerated Tartar.

The firſt of theſe that occurs, is regenerated Tartar.

From what has been before ſaid concerning the component parts of this ſalt, it may be eaſily inferred that it never is, nor can be found native.

The vegetable acid, though a natural production in the way of vegetation, is never found below the ſurface of the earth, and the vegetable alkali, the other component part, is not, in any reſpect, a native ſubſtance.

SALT OF ROCHELLE.

Salt of Rochelle.

The next in order is the ſalt of Rochelle, which may be excluded on the ſame account as the laſt mentioned, ſince although its alkaline baſis is a native foſſile body, yet as the vegetable acid is not ſo, they can never be found native in combination; on this account, therefore, it muſt be excluded.

VEGETABLE AMMONIAC.

Vegetable Ammoniac.

The laſt in the catalogue of the neutral ſalts is the Vegetable Ammoniac, commonly called Spiritus Myndereri.

For the reaſons before given in ſpeaking of the two foregoing ſubſtances, it will be eaſy to ſee the reaſons which muſt exclude this likewiſe.

From what has been ſaid, we find that the following are the only proper ſaline ſubſtances that can be expected to be found native in any Mineral Water.

Simple. Acid { Vitriolic acid per ſe.
Alkali { Foſſile Alkali per ſe
Volatile Alkali very dubious
Compound { Glauber's ſalt
Vitriolic Ammoniac very dubious
Common ſalt
{ Sal Ammoniac very dubious.

CHAP.

CHAP. IV.

Of MINERAL WATERS *impregnated with inflammable Subſtances**.

Diviſion of inflammable ſubſtances.

THE ingenious Author, whoſe diviſion of bodies has been choſen for the plan of this Work, has arranged inflammable ſubſtances under three heads, *viz. Oil, Sulphur*, and *Ardent Spirits.* From the preſence of one of theſe in their compoſition, it has been ſaid that all bodies derived their inflammability.

There ſeems to be, however, great reaſon to believe, that to theſe might be added an inflammable vapour, or air; ſome, indeed, have thought that this differed only from oils, or ardent ſpirits, as the vapour of water does from liquid water.

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* A body is called inflammable when, on the contact of a burning ſubſtance, it catches fire immediately in the part touching that ſubſtance from whence the fire is propagated over the whole maſs, till all of it, or the greateſt part, is entirely conſumed, and the reſt reduced to aſhes. During this a luminous vapour, called flame, floats on the ſurface of the burning body. Some have denied this laſt circumſtance to be an univerſal mark of burning bodies, as charcoal has the fire propagated from a ſmall part of it over the whole, which, undoubtedly, gives it a place among inflammable bodies, yet emits no flame from its ſurface. It is found, however, now, that a ſtream of air blowing on charcoal will cauſe it to flame like other inflammable ſubſtances.

There ſeems to be good reaſon for believing that an inflammable air exiſts, which is permanently in that ſtate. But as this differs ſo much in its form from other inflammable ſubſtances, it ſhall be treated of under the head of Aërial Bodies.

I ſhall treat of the foregoing inflammable ſubſtances in the order they are placed above. The firſt of theſe is

SECT. I.

OIL*.

Oils, vegetable, animal, and foſſile.

Oils are divided into vegetable, animal, and foſſile, and the two firſt are again ſubdivided into expreſſed, eſſential, and empyreumatic.

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* Oil is defined to be an inflammable fluid, and not miſcible with water, without the mediation of ſome other ſubſtance. All inflammable bodies were ſome time thought to owe their inflammability to an oil which they contained, becauſe there is ſome appearance of oil in ardent ſpirits, and ſulphur conſiſts of vitriolic acid, and ſome inflammable matter, which was ſuppoſed to be an oil. This notion is, however, now doubted, though they ſtill attribute the inflammability of all three to one common principle, which differs in its nature from any of them.

This

VEGETABLE *and* ANIMAL OILS *not found native in* MINERAL WATERS.

Vegetable and animal oils not found native in Mineral Waters.

It is very obvious, that no oil of the vegetable, or animal kind, can be ever found a foſſile ſubſtance, and, indeed, there is reaſon to believe, that if any quantity

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This principle has never been ſhewn by itſelf, and, indeed, is rather imagined than known; though, indeed, there is very great probability in favour of its exiſtence. It is called in Chemical books, the Phlogiſton.

Expreſſed oils are ſo called from their being contained in certain cells of animal and vegetable ſubſtances, and being produced by breaking down theſe cells by preſſure. They are of a mild bland taſte, have no peculiar odour, and are not miſcible with ardent ſpirits. Wax and fat belong to this claſs.

Eſſential oils have an acrid taſte, and remarkable odour, which is the ſame with that of the ſubſtance from which they are got. From their being ſuppoſed to contain the active part, or eſſence, of the bodies from which they were extracted, they have got the name of Eſſential. They are ſometimes, though improperly, called Diſtilled Oils, as they may be got often by ſimple expreſſion only, as in the rinds of ſome fruits, as oranges and lemons. M'quer has confined eſſential oils to the vegetable claſs. But muſk and caſtor, though procured from animals, are eſſential oils. Balſams and reſins likewiſe belong to them. They all diſſolve in ſpirits of wine, in which they differ from expreſſed oils.

Empyreumatic oils are acrid to the taſte, and ſtrongly odorous, but their odour is much the ſame from whatever ſubſtance they are got, and ſeems to be acquired by the application of a certain degree of heat, from which they have derived their name. They diſſolve eaſily in ſpirits of wine. Tar belongs to this claſs.

of either of theſe ſhould be by any artificial means introduced into the earth, that it would there be changed in its nature, and acquire the properties of the foſſile oil.

In conſequence of this, they muſt be excluded from the catalogue of native impregnations of Mineral Waters: And this opinion ſeems fully confirmed by experience, as there does not ſeem to be any traces of any ſubſtance of this kind diſcoverable from the analyſis of any water hitherto examined.

The only native ſubſtance then of this kind found below the ſurface of the earth, is the foſſile oil.

FOSSILE OIL, *per ſe.*

Foſſile Oil *per ſe.*

This is plentifully depoſited in many parts of the ſubterraneous kingdom, and, though under different forms, owing to the admixture of other bodies, is originally of one ſpecies only.

When in its utmoſt purity, it is perfectly thin and tranſparent, of a peculiar, yet not diſagreeable odour, and acrid taſte. In this ſtate, however, it is very rarely ſeen native. Its moſt common form is to be of the conſiſtence of a balſam, and of a brown colour. It is ſometimes found in both theſe ſtates, flowing out from the earth by itſelf, or joined with Water, but more frequently the latter. In its ſeparate ſtate, of which I am now ſpeaking, it does not admit of an intimate, or, properly ſpeaking, a chemical union with Water, by ſolution or mixture, but only of diffuſion through the body of it.

This, however, is often ſo minute, as to have the ſame appearance, and exert like effects with a chemical combination.

From the vaſt quantities of this ſubſtance that have been diſcovered below the earth, we might expect to ſee it more frequently in ſprings. The cauſe of this ſeems to be, that it is moſtly in a very impure ſtate, and united with ſubſtances which render it of a hard conſiſtence.

When thus combined, it is in a ſtate of too firm concretion to be united with Water, which, as has been before obſerved, can only admit of an union with it in the way of diffuſion.

Thus we ſee ſprings flow through numerous beds of pit coal, yet do not receive from them any impregnation of this kind. As, however, there are unqueſtionable proofs of its being ſometimes found native in a fluid form, and as ſeveral ſprings have been diſcovered containing it in its ſeparate ſtate, it muſt undoubtedly be ranked in the catalogue of native impregnations.

FOSSILE OIL *in a ſaponaceous form.*

Foſſile Oil in a ſaponaceous form.

It has been before remarked to be a quality of alkalies to unite oils with water in form of ſoap. As the foſſile alkali is confeſſedly found native below the ſurface of the earth in its ſeparate ſtate, it is poſſible to ſuppoſe that by this means the foſſile oil might be combined with Mineral Waters, in a more intimate manner than by that laſt mentioned, of ſimple diffuſion.

There ſeems to be, however, ſome objection to this, *viz.* that alkaline ſalts poſſeſs this quality only in their cauſtic ſtate, which does not appear to be the caſe with the foſſile alkali, as that, when found native in a ſolid form, is generally cryſtallized, which is commonly accounted a mark that an alkaline ſalt is in a mild ſtate, or ſaturated with fixt air.

From the eaſy cryſtallization of the foſſile alkali from the Mineral Waters that contain it, we may ſuppoſe that it is contained in them in a mild ſtate likewiſe. But it has been of late diſcovered, that cryſtallization is not ſo certain a criterion of the mildneſs of alkaline ſalts, as has hitherto been imagined.

It ſeems a true one, indeed, with reſpect to the vegetable alkali, but is by no means ſo of the foſſile and volatile alkali, which will cryſtallize when in ſome degree cauſtic. It does not ſeem improbable that it may be in this ſtate in Mineral Waters, and if ſo, would undoubtedly contribute to the more intimate union of them with any oily ſubſtance.

This conjecture ſeems more probable, as there is very good authority for aſſerting the exiſtence of Mineral Waters of this kind, though the inſtances are very few.

It muſt therefore be admitted into the catalogue of native impregnations.

SECT. II.

SULPHUR.

Sulphur.

Whether Sulphur ever makes a part of the native impregnations of Mineral Water, has long been a matter of great diſpute among the Writers on this ſubject.

As the point is of ſome conſequence, and has been both combated and ſupported in an able manner, I ſhall lay before the Reader the ſum of the arguments on both ſides, which have been well collected by the ingenious Dr. D. Monro, and ſubjoin afterwards ſome obſervations of my own relative to this point.

Firſt, then, it has been alledged, in ſupport of the opinion, that Sulphur is a native impregnation of Mineral Waters:

* That the fœtid ſmell of ſome waters reſembling Sulphur, is certainly not owing to

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* *Philoſophical Tranſactions*, Vol. LI. Art. 28.

to mere ſtagnation, and a conſequent putrefaction, as many of them have a briſk current.

Secondly, That putrid rain water, and many chalybeates turned putrid by keeping, do not diſcolour metals; neither do they cure cutaneous diſorders, as many of thoſe waters called ſulphurous do.

Thirdly, That the ſmell, flavour, and effects of ſome waters, and of their vapours, in diſcovering metals, are perfectly ſimilar to thoſe produced by the artificial ſolutions of Sulphur and of its vapours.

Fourthly, That many waters, called ſulphurous, contain the native foſſile alkaline ſalt, which is capable of diſſolving, and keeping ſuſpended, a ſmall portion of Sulphur.

Fifthly, That a milkineſs, or incipient precipitation, is produced in ſeveral of thoſe waters by dropping acids into them.

Sixthly, That a white heavy mucus is commonly precipitated on the ſticks or graſs over which ſuch waters paſs; and that at ſeveral fountains this mucus burns blue and ſmells of Sulphur, and that true yellow flowers of Sulphur have been got by ſublimation from the mud precipitated from ſome of them.

Seventhly, That a true and real Sulphur has been found floating in ſome cold ſulphureous waters.

Such are the principal arguments hitherto employed to prove the exiſtence of Sulphur in Mineral Waters.

In anſwer to theſe it has been alledged, that Sulphur can be diſſolved in water only by means of an alkaline ſalt, which gives the water a yellow colour, and on addition of acids an hepar ſulphuris is precipitated.

But it is ſaid, ſpeaking of Aix la Chapelle Waters, that theſe waters are clear and colourleſs, and that mineral acids preſerve its pellucidity, and prevent its becoming milky and dropping a ſediment.

Secondly, That the waters themſelves are not capable of diſſolving either their own or an artificial Sulphur.

Thirdly, That as to the Sulphur found adhering to the pipes through which the water flows, it does not proceed from the waters containing the Sulphur ſubſtantially diſſolved in them, but on account of their being impregnated with a phlogiſton and an acid, the principles of Sulphur, which being in a volatile ſtate are ſublimed, meet on the ſurface of the conduits, and there unite into a true and perfect Sulphur, which did not naturally exiſt in the water; and likewiſe, that part of this Sulphur, falling back again into the water, is precipitated to the bottom, which gives the mud a black colour and other ſulphureous properties.

That the fœtid ſmell, and property of tinging metals, which many of the cold waters called ſulphureous have, are entirely owing to their containing an oily matter, and undergoing putrefaction, which all waters are ſubject to, and that on trial none have given any clear and certain proofs of their containing Sulphur.

That the flowers of Sulphur, alledged to have been obtained by ſublimation from the mud of ſome of theſe waters, were generated by the force of fire, ſubliming and incorporating the phlogiſton and vitriolic acid,

cid, which were not before intimately
nited together in the waters.

These are the principal arguments which
ave been made uſe of by the moſt eminent
Vriters on both ſides.

And here I cannot help obſerving, that
ıe uſe of the term Sulphur, in an in-
efinite ſenſe, has occaſioned much con-
uſion, it having been applied to that
ubſtance in its proper form, and to the
everal forms of hepar ſulphuris. Theſe
t is of conſequence to diſtinguiſh, as
ulphur thus united acquires different pro-
erties from any it poſſeſſed in its ſimple
tate; and moreover, the different kinds
f hepar ſulphuris are endued with qualities
arying one from the other, as I ſhall
oon have occaſion to obſerve.

To remedy this inconvenience, there-
ore, whenever Sulphur is mentioned in
he enſuing Work, I deſire it may be
nderſtood of Sulphur in its proper form,
r not combined with any body that
hanges its nature.

I propoſe then to conſider, firſt, Simple
ulphur as an ingredient in the compo-
ſition

ſition of Mineral Waters; and afterwards the two varieties of hepar ſulphuris.

Sulphur *per ſe.*

Sulphur *per ſe.*

This ſubſtance is undoubtedly found native in the earth ſometimes, though rarely, in pure bright yellow ſemi-tranſparent maſſes, but more commonly in opake ones, of a greeniſh, greyiſh, or other colours, intermixed with earthy and ſtony matters. But the principal matrix of Sulphur is the ferrugineous ore, called, from its colour and ſtriking fire with ſteel, *Yellow pyrites.*

As the proportion of Sulphur here is very large, it appears to contain a conſiderable quantity in its native form, and this ſeems to be the caſe with ſeveral others of the metallic ores.

But in this ſtate Sulphur is totally inſoluble * in water, and may, therefore, be

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*Experiment I.

Two drachms of waſhed flowers of ſulphur were added to eight ounces of diſtilled water, heated to 120 degrees. They were ſuffered to ſtand four hours together, in a cloſe veſſel, and then filtred off. The liquor had not the leaſt taſte ſafely rejected, in its diſſolved ſtate, from the catalogue of native impregnations.

Notwithſtanding theſe arguments, I am inclined to believe, that Sulphur, in its pure and unmixed ſtate, makes a part of the compoſition of ſeveral Mineral Waters. In thoſe of Aix la Chapelle, for inſtance, it is found pure, and in large quantity, daily ſeparating from them; and though a great Writer, whoſe argument on this head has been lately mentioned, has attempted to elude the force of this circumſtance; yet I apprehend, his reaſoning, though ingenious, is ſcarce ſatisfactory.

I have been credibly informed, that at Aix la Chapelle the Sulphur is not only found on the ſurfaces of the reſervoirs and conduits, which lie above the water, and into which it ſublimes, but that the pipes, through which it runs, are uniformly lined on all ſides with Sulphur ſtrongly adhering

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taſte or ſmell of ſulphur, nor did any precipitation happen on adding a ſolution of ſaccharum ſaturni in water.

EXPERIMENT II.

A lump of yellow pyrites, previouſly waſhed, was boiled an hour in two pounds of diſtilled water, without imparting the leaſt ſulphureous impregnation that could be diſcovered, to them, and of an equal thickneſs, reſembling much more a gradual precipitation from the water, than (as he ſays) pieces that have accidentally dropped in from the places into which it had ſublimed.

He himſelf allows, that the waters contain the component parts of Sulphur, *viz.* an acid, and the principle of inflammability, and as theſe two attract each other more ſtrongly than any other body, what reaſon can be given why they may not be ſuppoſed to unite when intimately applied to each other, as floating in the ſame fluid, as well as when ſublimed together from it?

But, by his own account, ſublimation is not neceſſary to unite them, ſince he afterwards tells us, that theſe waters, drank for ſome time, give a ſulphureous ſmell to the whole body, tinge the patient's linen of a yellow colour, and even tarniſh and turn black ſilver carried in the pocket.

The ingenious Dr. Monro has obſerved, likewiſe, that theſe waters cure the itch, or other cutaneous diſorders, in the ſame manner as Sulphur, which is no quality of either of its component parts when ſeparate. The ſame learned Author has mentioned ſeveral inſtances, from good authority, of Sulphur being ſo largely contained in ſome waters ſo as to be got by evaporation.

It ſeems moſt likely to ſuppoſe, that in theſe waters the ſulphur is ſuſpended by means of a ſubtile diffuſion. Were it diſſolved in them by means of an alkali, it would manifeſt itſelf by its taſte and ſmell, reſembling a rotten egg, or ſcowring of a foul gun barrel; yet ſome of theſe waters, though they have a ſulphureous taſte and ſmell, are yet very diſtinguiſhable from that of the hepar ſulphuris. Add to this, that the waters impregnated with hepar ſulphuris do not ſpontaneouſly depoſit their ſulphur in the manner thoſe of Aix la Chapelle do, and when ſtrong ſhew a precipitation on addition of acids, which is not the caſe with thoſe containing ſimple ſulphur. The like argument will hold againſt their impregnation with ſulphur by means of quick-lime, as it does not eaſily ſeparate when thus diſſolved; and moreover ſulphur ſeems to be contained in ſome waters in larger proportion than could be done by theſe means. If, therefore, it be admitted that ſulphur may be contained in a Mineral Water in a diffuſed ſtate, it will rationally account for the ſpontaneous precipitation of it from them, as at Aix la Chapelle, and will obviate the objections drawn from chemical experiments, ſuch as its not being precipitated by acids, *&c.* as in this ſtate it is not in the leaſt affected by them. To this, perhaps, it may be objected, that although it cannot be denied that ſulphur is ſometimes found native in the earth, yet that it is then either in a hard compact form of cryſtals, or united with other ſubſtances, which give it a ſtill firmer concretion, as in the caſe of pyrites, in either of which ſtates it ſeems very unlikely to be carried along with a current of water, and for a time at leaſt ſuſpended in it, which would require the moſt minute diviſion poſſible of its parts. To this, however, it may be replied, that moſt of the ſprings in which there is reaſon to believe Sulphur is contained in this ſtate, are of the thermal kind, and which probably owe that quality to ſome ſubterraneous fire adjacent to the current of their ſtream, as it riſes to the ſurface. It is well known, that Sulphur, when air is excluded, may be ſublimed by mere force of fire, from pyrites in its pure ſtate in form of flowers. It is not unlikely, then, that Sulphur may be thus accumulated in ſome ſubterraneous caverns, too deep for our reſearches, into which it may have been ſublimed, and thus intermix with the current of a ſpring paſſing through it. This will account for its being thus contained in the water, as in the form of flowers it is the moſt minutely ſubdivided poſſible, and of conſequence the moſt likely to be carried along with a ſtream of water.

The ingenious Mr. Macbride has, by an experiment of his, ſuggeſted a method, by which a ſpring may be impregnated with Sulphur, in its pure ſtate, in the way of ſolution.

He made a ſolution of Sulphur in Water by means of quick lime, and by injecting currents of fixt air upon the ſurface of it, found the calcareous earth to precipitate, leaving the Sulphur diſſolved in the Water. I ſhall ſpeak of this more largely when I come to treat of Waters impregnated with hep. ſulph. cum calce vivâ, but ſhall obſerve here, that, granting the fact, it does not appear to be the caſe in all Waters that tain pure Sulphur, as ſome of them ſeem to contain it more plentifully than could be done by this means; and moreover, by Mr. Macbride's own account, the Sulphur thus diſſolved, does not ſpontaneouſly precipitate as it does from ſome of the Sulphureous Waters.

I am, therefore, though not without ſome degree of doubt, inclined to admit Sulphur in this form into the catalogue of native impregnations.

HEPAR SULPHURIS *with an* ALKALI.

Hepar ſulphuris, with an Alkali.

There is not the leaſt doubt that this is frequently found native in ſprings. Its ſmell and taſte are ſo diſcernible, as to leave no room for a miſtake of this for any other ſubſtance.

Moreover, the blueiſh white precipitation, which ſeveral of them give on addition of acids, and which, when collected, proves to be a pure Sulphur, and the black colour induced on a paper, moiſtened with a ſolution of Sacch. Saturni, ſhew this very clearly. Some have incautiouſly rejected this from the catalogue of impregnations, as it was not to be diſcovered in the reſiduum left on evaporation.

This, however, is not a ſufficient reaſon, ſince, if we were to make an artificial impregnation of a Water of this kind, of the ſame ſtrength with what we ſee it in ſprings, we ſhould diſcern no traces of hepar ſulphuris in the reſiduum left on evaporation, as that ſubſtance ſuffers a decompoſition by ſolution in Water, and, moreover, the Sulphur itſelf would be diſſipated by the degree of heat and continuance of it neceſſary for the evaporation.

The frequency of this impregnation argues ſtrongly in favour of what has been before advanced, *viz.* that the foſſile alkali is not always found, when native in the earth, in a perfectly mild ſtate, as, when ſaturated with fixt air, it unites very imperfectly with, and enables water to diſſolve but a ſmall portion of Sulphur; whereas ſome ſprings are largely impregnated with hepar ſulphuris.

'Tis almoſt needleſs to obſerve, that this circumſtance corroborates the opinion before delivered, that the foſſile oil is ſometimes found in ſprings in a ſaponaceous form.

On the whole, then, there is no doubt that this ſubſtance is a native impregnation of Mineral Waters.

HEPAR SULPH. *with* QUICK-LIME.

Hepar Sulph. with Quick-lime.

Calcareous earths, when deprived of their fixed air, unite with Sulphur in the ſame manner with alkalies, and poſſeſs the ſame property, though not in ſo great a degree, of rendering it miſcible with Water

As calcareous earth is ſo generally diſperſed through the ſubterraneous kingdom, it ſhould ſeem likely that Sulphur might be frequently found in this ſtate in Mineral Waters.

The ſame objection, however, occurs here, as in the laſt mentioned inſtance, *viz.* that calcareous earth is moſtly found united with fixt air, in which ſtate it will not unite with Sulphur.

This ſeems proved by the hardneſs and firm concretion of many marbles, which probably owe thoſe qualities to the fixt air ſerving as a bond of union, as ſuggeſted by the ingenious Mr. Macbride. This opinion is ſupported by their ſtrong effervefcence with acids. Other earthy bodies, of a more mixt nature, which are of a very firm texture, ſeem to owe their coheſion to the calcareous earth interpoſed between the other parts, which, being ſaturated with fixt air, keeps them together.

Thus we ſee many ſtones which fall into pieces on calcination, though but a ſmall part of their compoſition conſiſted of calcareous earth.

Calcareous earth, likewiſe, though of a looſe texture, is found united with fixt air. Thus chalk, whoſe concretion is very ſlight, effervefces ſtrongly with acids, and has ſcarce any effect upon Sulphur. Theſe reaſons lead us to conclude againſt the probability of the exiſtence of this impregnation. Yet I am inclined to think that the rule is not univerſal.

And here I muſt obſerve, that both alkalies and calcareous earths will unite with fixed air in different proportions, ſo as to form different degrees of cauſticity. Whether the fixt air in this caſe, when inſufficient to ſaturate the whole, unites itſelf to a part, rendering that perfectly mild, and leaving the reſt cauſtic as before; or whether it affects the whole, and is equally diſperſed over it in leſs proportions, ſo as to form a kind of intermediate ſtate between cauſticity and mildneſs, would be a curious queſtion.

From analogy of acids and alkalies, the former would ſeem probable, but I think obſervation and fact favour the latter opinion*.

Thus much is certain, that ſeveral foſſile bodies, when firſt dug, are in a ſtate of attracting fixt air from the atmoſphere. Thus chalk does not efferveſce with acids ſo ſtrongly when firſt got as when kept ſome time, and moreover by that acquires a greater degree of hardneſs, which can be only owing to its attracting fixt air. Many kinds of ſtone, likewiſe, when firſt dug, yield eaſily to the tool, ſo as to be worked with equal eaſe as wood; but when uſed in building, or expoſed to the air, acquire a great degree of hardneſs, ſo as ſcarce to bear any impreſſion to be made on them.

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* Mercury and Antimony ſeem to admit of an union with acids in a manner ſomewhat analogous to this.

I have obſerved, however, in the large pieces, that this acquired hardneſs decreaſes as you pierce into the body of the ſtone, and that in the middle of a large block there is ſtill a part remaining ſoft and friable.

I have alſo remarked of all theſe ſtones, that they univerſally contain a conſiderable portion of calcareous earth, and the remainder moſtly cryſtalline.

From what has been ſaid we may reaſonably conclude, that the calcareous earth in theſe ſtones is, in ſome degree, in the ſtate of quick-lime, and that its hardening on expoſure to the atmoſphere was owing to its attracting fixt air from it, in the ſame manner as quick-lime does.

I ſhall give ſome experiments, tending to prove this point more fully, in the third part of this Work.

If, then, it be ſuppoſed, that calcareous earth, in its native ſtate, ſometimes poſſeſſes a degree of cauſticity, it will be eaſy to account for the impregnation of waters with this kind of hepar ſulphuris. I have found by experience, that quick-lime, when it had remained ſeveral weeks in a powdery form expoſed to the air, and even effervesced in ſome degree with acids, ſtill retained enough of its cauſticity to diſſolve, by aſſiſtance of heat, a portion of Sulphur, and I even found this effect in ſome degree, tho' very ſlight, from a piece of freſh chalk.

I am, nevertheleſs, of opinion, that this impregnation is not to be expected to be found, except in the Thermal Waters, as I find that calcareous earth, in its moſt cauſtic ſtate, as quick-lime, enables water to diſſolve but a very ſmall portion of Sulphur, unleſs aſſiſted by heat. By that, however, its ſolvent powers are greatly increaſed. Probably it is owing to this circumſtance, that this impregnation is not more frequent. With this reſtriction, nevertheleſs, I cannot but admit it into the catalogue of native impregnations of Mineral Waters.—

The laſt diviſion of inflammable ſubſtances is

ARDENT SPIRIT.

Ardent Spirit.

This, though of ſeveral degrees of ſtrength, and variety of appearance, is ultimately of one kind only, and never produced, except in conſequence of the vinous fermentation, which there is not the leaſt reaſon to think ever does, or can take place below the ſurface of the earth, as a communication with the air is neceſſary, and, moreover, it is generally thought no native foſſile ſubſtance is capable of it.

This being premiſed, it is eaſy to conclude, that Ardent Spirit never can be found native in ſprings. Nevertheleſs, there are ſome circumſtances occurring in nature, that ſeem at firſt ſight to render this fact rather doubtful.

Herodotus, Polybius, Ovid, and Plutarch mention ſprings of a briſk vinous taſte, ſparkling appearance, and intoxicating qualities, and the laſt of theſe properties, and ſome degree of the two former, are remarkable in ſeveral ſprings that have fallen under modern obſervation. How this ſimilarity of effects is to be accounted for, ſhall be conſidered when I come to treat of Aërial Bodies. At preſent I ſhall only ſay, that it is very probable that this effect is owing to the ſame cauſe in both caſes, the ſubſtance producing it being largely contained in many foſſile ſubſtances, and likewiſe conſtantly preſent in the vinous fermentation. This cauſes that briſk taſte, ſparkling appearance, and inebriating qualities of ſome Mineral Waters, ſo much reſembling the effects of fermented liquors; but it does not appear that any of the ſprings that poſſeſs theſe qualities in the greateſt degree, could, by any means, be brought to yield the ſmalleſt quantity of any ardent ſpirit on diſtillation; a certain mark of their containing none. This ſubſtance, then, may be ſafely rejected from the catalogue.

The native impregnations of Mineral Waters with Inflammable Bodies are:

Oil.	Simple.	1. Oil foſſile *per ſe* in a ſtate of ſimple diffuſion.
	Compound.	2. Oil in form of ſoap.
Sulphur.	Simple.	3. Sulphur *per ſe* in a ſtate of diffuſſion.
	Compound.	4. Hepar Sulph. with an alkali.
		5. Hepar Sulphuris with quick-lime.

CHAP.

CHAP. V.

Of MINERAL WATERS *impregnated with Metallic Subſtances.*

IT is a characteriſtic of this claſs of bodies, to admit of no chemical union with Water, whilſt they retain their metallic form, and to be only miſcible with it by means of ſome other body, which reduces them into a ſaline ſtate*, in which, alone, they are capable of it. Solution, then, is the only method by which they can be thus united. Saline bodies, or at leaſt bodies poſſeſſed of ſaline qualities, are probably the only ſolvents of metals we are acquainted with, and we may be well aſſured, that every metallic ſolution in Water contains a portion of ſome ſaline ſubſtance, combined with the metal. It may be objected, perhaps, that the ſeveral kinds of hepar ſulphuris, and ſome aërial ſubſtances, which are not ranked in the claſs of ſaline bodies, poſſeſs the property of rendering ſome metallic ſubſtances miſcible with water. But it ſhould be conſidered, that pure ſulphur has no ſuch effect, but rather a contrary one; nor is any ſuch produced until the ſulphur is formed into a compound poſſeſſed of ſaline qualities, *viz.* ſapidity to the taſte, and ſolubility in water. Moreover, in the hepar ſulphuris formed with an alkali, which is much the moſt active in this way, the alkali itſelf, in the ſtate in which it properly admits of an union with ſulphur, is a diſſolvent of ſome metallic ſubſtances. It muſt be confeſſed, indeed, that it ſeems to form a kind of neutral body with the ſulphur, and to acquire new properties in this way. With regard to aërial ſubſtances, it is more than probable that they act by means of ſome ſaline quality adhering to them.

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* Though it ſeems pretty clear, that all metallic bodies owe their ſolubility in water to their being reduced to a ſaline ſtate, it is not meant that every combination of a metal with a ſaline body is ſoluble in water. Some of them ſeem to be decompoſed by ſuch addition, the water attracting the acid from the metal, and leaving only the calx. Thus the vitriolic and nitrous acids may be waſhed out by water from antimony; and the precipitation of ſilver from the nitrous acid, by means of the muriatic, by frequent waſhing becomes mild. Other ſaline bodies likewiſe only diſſolve metals when in a concentrated ſtate, and when diluted with water again let them fall.

The common air has been proved to contain a portion of ſaline ſubſtance, and in ſome of the hotter climates, is perceptibly ſaline to the taſte.

This quality, likewiſe, is very diſtinguiſhable in the air, ariſing from effervescent mixtures when accumulated, and there is reaſon to think that a ſaline quality accompanies the air ſet looſe by fermentation, and even that produced by putrefaction. The inflammable vapour, likewiſe, produced during the ſolution of metals in acids, partakes likewiſe of a ſaline nature.

Some oily ſubſtances, indeed, are found to act upon metals, but this is probably (in the vegetable oils,) in conſequence of their containing ſome of the eſſential ſalt of the plant from which they were got. This is very evident in turpentine, where the eſſential ſalt often cryſtallizes by itſelf, and the ſame is true of the empyreumatic oils, as tar, from which a ſaline quality may be extracted by water.

Expreſſed oils, both animal and vegetable, act upon metals more powerfully when rancid, which, perhaps, is owing to their generating a volatile alkali; and what ſeems to add weight to this is, that they then become miſcible with water, which is probably cauſed by the intervention of that ſubſtance, as forming a kind of ſoap.

Eſſential, expreſſed, and even empyreumatic oils will unite with the calces made by fire of ſome metals very largely, and with others, when reduced into a ſaline ſtate, by acids. But they have no ſuch effect on them in their metallic ſtate, except in conſequence of their combination with ſome ſaline ſubſtance, nor is the compound thus formed in any caſe miſcible with water.

I ſhall now proceed to treat of metallic ſubſtances ſeparately, and examine them with reſpect to the means by which they may be rendered miſcible with water. But as this is meant with a reference to the ſubject, *viz.* of determining the metallic impregnations of Mineral Waters, no ſubſtances can be conſidered here as having that effect, except ſuch as are native foſſiles. Every metallic ſubſtance, therefore, which is not miſcible with water by means of theſe, I ſhall not heſitate to deny its exiſtence as a native impregnation of ſprings.—I ſhall take them in the order in which they are generally ranged, firſt, the pure metals, next the baſe metals, and laſtly the ſemi-metals.

SECT. I.

PURE METALS.

GOLD.

Gold.

GOLD, in its metallic form, is not in the leaſt affected by any of the foſſil proper ſaline ſubſtances. The vitriolic acid may, indeed, be made, in certain circumſtances, to diſſolve it, but this only takes place when it has been previouſly diſſolved, and precipitated again from its proper menſtruum. Hepar ſulphuris, indeed, will act upon it in its metallic ſtate, and render it ſoluble in water; but to bring about this, it is neceſſary that the Gold ſhould be fuſed along with it.

As the proper menſtruum of Gold, *viz.* aqua regia, or a mixture of the nitrous and muriatic acids, is never found native, it can never be in a capacity of being rendered ſoluble by the firſt of theſe means; and as the degree of heat neceſſary to bring about the other does not occur in nature, there can be as little probability on that ſide. How far ſuch a ſolution might accidentally happen by means of a volcano, or ſubterraneous fire, is not eaſy to determine. But if it ſhould occur, it could not form an impregnation of a Mineral Water, as the vitriolic acid has this effect only in a concentrated ſtate, and, when diluted with water, again depoſits the metal.

What confirms the above theory is, that Gold has never been found native in a ſaline, or cryſtallized ſtate, nor even, as moſt agree, in a mineralized one, but always in its metallic form. All theſe circumſtances then concur to prove, very clearly, that it never can be an ingredient in any Mineral Water.

SILVER.

This metal, as well as the foregoing, has never been found impregnating a Mineral Water. Its proper menſtruum is the nitrous acid, which is never found a foſſile ſubſtance; and though the vitriolic acid has this effect in ſome degree likewiſe, yet it doth not act upon it, except in a boiling heat and concentrated ſtate, and, when diluted with water, depoſites it again in the ſame manner as it does Gold: Hepar ſulphuris likewiſe does not affect it except in fuſion. None of the other foſſile ſaline ſubſtances affect it in the leaſt. It may, therefore, be excluded. Silver.

SECT. II.

BASE METALS.

COPPER.

Copper, in its metallic form, is acted upon by all the foſſile ſaline ſubſtances. The vitriolic acid has been thought by ſome not to diſſolve it, except when the acid was in a concentrated ſtate, and aſſiſted by a conſiderable heat. Theſe opi- Copper.

nions are, however, erroneous. The fixed Vitriolic Acid * acts, indeed, when dilute, very ſlowly upon copper in the cold, but will, nevertheleſs, completely diſſolve it; and when the Acid is in its volatile ſtate †, as it is ſuppoſed to be always when foſſile and uncombined with any other body, its ſolvent power is very conſiderable, though the effect of this likewiſe is much increaſed by heat.

‡ The foſſile alkali, probably only corrodes copper, and when much diluted,

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*EXPERIMENT I.

Sixty drops of the vitriolic acid were added to two ounces of diſtilled water, in which were put a ſcruple of copper filings; they were ſuffered to ſtand together about twelve hours, and then the liquor was filtred off. It was nearly colourleſs, but had an evident taſte of copper; and, on adding a few drops of ſp. ſal. ammon. cum calce viva, ſtruck a fine blue colour. The filings appeared in part corroded.

† EXPERIMENT II.

Sixty drops of ſpiritus ſulphuris per campanam, freſh made, were added, in like manner, to two ounces of diſtilled water, with a ſcruple of copper filings. After ſtanding twelve hours, the liquor was filtred off. This ſtruck a deeper blue on addition of a like quantity of ſp. of ſal. ammoniac, and the filings appeared more corroded than in the preceding Experiment.

‡ EXPERIMENT III.

Twenty grains of native foſſile alkali, got by cryſtallization from the reſiduum of the waters of Carlſbad, in Bohemia, which contain it nearly pure, were added to two ounces of water, in which were put ten grains of copper filings; theſe even this very ſlowly, if any, and if the air is excluded, not at all.

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theſe were ſuffered to ſtand ſeveral days in an open veſſel. The copper filings were not diminiſhed in weight, or appeared to be at all corroded, but had acquired a browniſh duſky colour; the liquor was then filtred, and appeared clear and colourleſs, without any taſte of copper. I then added twenty drops of ſp. vitrioli, which was more than ſufficient to ſaturate the alkali, and rediſſolve the copper had any been contained in it. I then added a drachm of ſp. ſal. ammon. cum calce viva, but no blue colour was produced, a ſure ſign the water contained no copper. A few grains of the dry alkaline ſalt mixed with copper filings, in a few days evidently corroded them.

EXPERIMENT IV.

Two drachms of Glauber's ſalt were diſſolved in two ounces of diſtilled water, to which was added a ſcruple of copper filings; the filings ſeemed little affected by ſtanding in it twenty-four hours, and not more than ſome that were in common water, being only of a rather duſky colour. The liquor was then filtred, and was perfectly clear, had no taſte of copper, and ſtruck no blue on addition of ten drops of vitriolic acid, and one drachm of ſp. of ſal ammoniac.

N. B. Common ſalt and ſal catharticus amarus were tried, in like manner, without effect.

I muſt obſerve, that what is here ſaid, ought, by no means to encourage us to employ copper veſſels in our culinary operations, where we have occaſion to make uſe of ſaline ſubſtances of any kind, as all of theſe, when concentrated and aſſiſted by heat, will corrode; and ſome of them, in theſe circumſtances, even diſſolve copper. In the former of theſe ſtates even it would be eaſily ſeparated from the ſides of the veſſel, and thus mixed with our food, and, in this ſtate, if taken into the body, would be eaſily diſſolved by the acid of the ſtomach, and exert the effects of verdigris.

Its ſolvent power ſeems increaſed by heat, but on cooling, it depoſits what it had before diſſolved. Glauber's ſalt, ſal cathart. amarus, and common ſalt, likewiſe, when in a ſtrong ſolution, corrode it, but the compound they form with it, does not diſſolve in Water.

When diluted, they do not ſeem to act upon it, and probably in that caſe let go what they had before taken up.

The volatile alkali, indeed, acts very powerfully in diſſolving Copper, but its exiſtence as a native ſubſtance is too dubious to ſuffer us to admit it as an impregnation of ſprings. It certainly can never take place, except in extraordinary circumſtances, ſuch as the neighbourhood of volcanoes, *&c.*

* Fixt air, likewiſe, does not render Copper ſoluble in water, as it does iron. The

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* EXPERIMENT V.

Ten grains of filings of copper were mixed with two ounces of diſtilled water in a vial, and by means of a crooked tube, numerous ſtreams of fixible air from an efferveſcent mixture were driven on the ſurface of the liquor. The filings remained ſeveral days unaltered, and the liquor had not gained any taſte of copper. It was then filtred, and appeared vitriolic acid, then, appears to be the only foſſile ſaline ſubſtance, which, when diluted with water, is capable of holding Copper diſſolved, and of conſequence the only one with which this metal can be found united in a Mineral Water.

Experience confirms this opinion, as all the Mineral Waters hitherto diſcovered, that are impregnated with copper, contain it in the ſtate of blue vitriol.

This impregnation does not occur ſo often as we might expect, from the frequency of Copper, as a foſſil body, on account of the great quantities of iron every where diſperſed through the bowels of the earth, which precipitates * it, and, moreover, the metal is ſeldom found native in a ſtate capable of being acted upon, being either mineralized by ſulphur, or, if in its metallic form, ſo firmly concreted with

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appeared perfectly colourleſs, and tranſparent. To the filtred liquor were added three drops of ſp. vitrioli, and afterwards a ſcruple of ſp. ſal. ammon. cum calce viva, but no blue colour appeared.

* *A priori*, we might expect to meet with this impregnation moſt frequent in the thermal ſprings, as the vitriolic acid, when heated, attracts copper ſtronger than even iron. Perhaps the degree of heat is ſeldom ſufficient to have this effect.

ſome ſtony ſubſtances, as not to admit of the action of any menſtruum upon it. It is, notwithſtanding, ſometimes found native in the earth, in a ſtate of union with the vitriolic acid, and has been diſcovered preſent in ſprings, though not frequently in this form. It muſt, therefore, be accounted a native impregnation.

—— *Form* in which Copper is contained in Mineral Waters.

United with the vitriolic acid in form of **Blue Vitriol.*

IRON.

Iron.

Impregnations of Mineral Waters with Iron occur more frequently than any others of the metallic kind. Several things concur to bring this about. The eaſy ſolubility of Iron in ſeveral ſaline fluids, and the ſuperior ſtrength of attraction which it has to them in compariſon with all the other metallic ſubſtances, except Zinc, afford a very evident cauſe of this circumſtance.

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* I have ſince found, that alum acts upon copper in the way of ſolution, ſo that it is not improbable that this metal may be found preſent in thoſe waters that contain this ſaline ſubſtance. Alum may be conſidered as acting upon metals in two ways, either in conſequence of its ſuperabundant acid, or by a decompoſition of its parts, the acid being attracted by the metal ſtronger than by the earth of alum. But in either of theſe caſes the metal would be united with the acid only, and would conſequently appear in form of blue vitriol. See more on this head, in the next article concerning Iron.

The vitriolic acid, in its fixed ſtate, and when much diluted, acts very powerfully upon Iron; and there is no doubt that this combination is ſometimes to be met with in Mineral Waters. This is evidently poſſible, from the proofs we have of green vitriol in its cryſtallized ſtate being found a native foſſile; and what confirms it is, that the ſame body has been got in a cryſtallized form, by the evaporation of the water of ſprings. This, however, can but ſeldom be the caſe, unleſs the proportion contained be very large, as, otherwiſe, the acid part would be diſſipated during the evaporation, it being rendered, in ſome degree, volatile by being united with Iron.

But a more common impregnation of this kind is by means of the ſame acid in its volatile ſtate, in which it acts more powerfully upon Iron than in the fixed.

This impregnation may be eaſily accounted for, from the vaſt quantities of iron pyrites ſo generally diſperſed through the bowels of the earth, from which that acid (as has been before obſerved*) is always ſeparated in its volatile ſtate, and capable of acting immediately on the iron. In all probability, this impregnation would be more ſtrong and frequent, were it not that the iron pyrites is ſcarce decompoſed, unleſs the air has acceſs, in ſome degree, which can ſcarce happen ſo often in nature as to account for the numbers of chalybeates that we ſee of this kind. Neumann has, however, mentioned, and I have myſelf ſeen, ſome kinds of pyritæ which ſuffer, though ſlowly, a degree of decompoſition, even in cloſe veſſels, which may account for this appearance.

The foſſile alkali acts upon Iron in the way of corroſion, but I cannot find that it† diſſolves any.

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* *Vide* Sect. I. on ſaline ſubſtances.

† Twenty grains of iron filings were added to two ounces of water in a vial, containing a drachm of foſſile alkali. On ſtanding four days expoſed to the air, the filings appeared much corroded. Half an ounce was then filtred off, and appeared perfectly clear. To this was added, drop by drop, ſpirit of

Some have been of opinion, that if to Iron, previouſly diſſolved in the vitriolic acid, the alkali be added in greater proportion than will ſaturate the acid, that part of the * precipitated metal will be re-diſſolved. Were the fact true, it might be eaſily ſuppoſed to happen in nature, by the interfering of the current of two ſprings, one containing an acid chalybeate, and the other an alkaline quality. But on experiment I cannot find that, in this caſe, the ſmalleſt particle of the Iron is re-diſſolved; probably its action upon the metal, if any, is confined to it when highly concentrated. —I cannot, therefore, allow it to be accounted a native chalybeate impregnation.

The volatile alkali does not act upon iron in the way of ſolution in its metallic ſtate,

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of nitre, till the effervefcence ceaſed; I then added ſome powdered galls, but not the leaſt purple or black colour was produced.

* A ſcruple of green vitriol was diſſolved in two ounces of water. To this was added two ſcruples of the foſſile alkali, which was more than ſufficient to ſaturate the acid. An ochrous precipitation enſued, which ſoon collected at the bottom of the vial. The liquor was then poured off, and filtred clear. To this was added, drop by drop, ſpirit of vitriol, until all effervefcence ceaſed. I then added a little powdered galls, but no purple or red colour was perceived, nor was there any precipitation on adding the acid.

ſtate, nor does it attract acids ſo ſtrongly. It never can, therefore, be the foundation of a chalybeate quality in Mineral Waters.

*Glauber's ſalt, the ſal catharticus amarus, and common ſalt, corrode iron, but do not diſcover any effect in rendering it ſoluble in water.

Mineral Waters, impregnated with † hepar ſulphuris, have the power of diſ-

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* Two drachms of Glauber's ſalt, ſal catharticus amarus, and common ſalt, were diſſolved, each of them in two ounces of water, in ſeparate vials, and to each of them added twenty grains of ſteel filings. They were ſuffered to ſtand four days, and then from each was filtred half an ounce of the liquor, and to each half ounce was added two drops of ſpirit of vitriol; I then added galls, both in ſubſtance and ſolution, but no black or purple colour appeared, though I ſaturated the ſuperabundant acid, after adding the galls with lixiv. ſaponarium. The above Experiment was tried with the aſſiſtance of heat, but without effect. It was alſo tried with ſelenites.

† Four ounces of Harrogate water were put into a bottle with a ſcruple of iron filings, and ſuffered to ſtand twenty-four hours, and then filtred. It ſtruck a very deep black with galls. This ſucceeded in a great degree with ſome Harrogate water that had been expoſed to the air near three weeks, by the bottle being left open, and ſuffered a large precipitation.

Leſt the aforeſaid effect ſhould be attributed to the fixt air in the water, though I ſhould think that obviated by the circumſtance mentioned of its long expoſure to the air, I made the following experiment. I took two drachms of flowers of ſulphur, and added to them one drachm of lixivium ſaponarium, and rubbed them well in a mortar together, ſolving Iron, though but in moderate proportion. Probably this varies in proportion to the degree of impregnation. I am inclined to believe that there may be native chalybeates of this kind.

Hepar * ſulphuris cum calce vivâ, likewiſe poſſeſſes ſome powers of this nature, though not ſo great as the hepar ſulphuris with an alkali. As I believe the former of theſe to be a native impregnation, I muſt alſo admit a chalybeate one by means of it, into the number.

No ſimple earthy ſubſtance has, as far as I can find, the leaſt effect in rendering Iron ſoluble in water.

The earthy ſaline body called † alum,

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gether, and gradually added ſix ounces of diſtilled water. The whole was then filtred, and to it added twenty grains of ſteel filings; after ſtanding ſix hours, I added a little ſolution of galls, and it immediately ſtruck a purple colour.

[*] A drachm of flowers of ſulphur was added to half an ounce of quick-lime and ſix ounces of water, and boiled together for ſome time, and then filtred. To the filtred liquor was added a ſcruple of iron filings. After ſtanding four hours, it ſtruck a light purple with ſolution of galls.

[†] A ſcruple of alum was diſſolved in two ounces of water, and to it added ſome iron filings; after ſtanding an hour, it ſtruck a deep black with ſolution of galls. As there appeared little precipitation, in all probability the iron was here diſſolved by the ſuperabundant acid, which is always adhering to or united with alum, in the ſtate we get it.

has,

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has, indeed, this effect in a conſiderable degree upon Iron in its metallic ſtate. But this cannot properly be accounted a native impregnation, as the Iron is not united with the alum, but with one of its conſtituent parts, viz. the vitriolic acid; the Iron attracting that acid ſtronger than the earth of alum does, and thereby decompoſes it, ſo that it would appear to us in the form of green vitriol, and not as united with alum. It muſt, therefore, be referred to the firſt head of chalybeates.

Mephitic air has been of late diſcovered, by the ingenious Mr. Lane, to be a powerful menſtruum for Iron, and from the frequency of its preſence in chalybeate waters, he concludes it to be the medium by which they often become impregnated. He has beſides ſuggeſted a probable method, by which we may account for its being preſent in ſprings, on ſuppoſition "that the water might be firſt charged "with a pyritical matter (by which, I apprehend, he means a ſolution of Iron in the vitriolic acid, as it is extracted from pyrites,) "which might have the acid part "neutralized by alkaline or calcareous

" ſubſtances, and yet the Iron remain " ſuſpended by air generated during the " ſaturation."

I have made ſome experiments * myſelf which have agreed perfectly with thoſe made by that ingenious Gentleman, and all tend to prove indiſputably, that fixt air is itſelf ſufficient to form a ſolution of Iron, without calling in the aid of any other menſtruum. It was at firſt imagined by ſome, that the ſolution of Iron, in this manner, might be owing to a portion of acid adhering to the fixt air, ſince the latter ſubſtance is generally procured for the purpoſes of experiment, either by fermentation, or from effervеſcing bodies. In the firſt of theſe it has been often thought that an acid was always produced, and in the latter an acid ſubſtance is always neceſſary; part of which might be forcibly carried along with the ſtream of fixed air,

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* Half an ounce of ſteel filings were added to four ounces of diſtilled water in a vial, and on the ſurface of this was driven ſeveral ſtreams of air from a mixture of the foſſil alkali with the vitriolic acid. An ounce of this water, after filtration, gave a black colour with tincture of galls. I found the ſame effect, with ſome difference in the tinge, from magneſia and calcareous earth joined to the vitriolic acid.

ruſhing violently out from the effervеſcing mixture. But it appears to me, that theſe objections are void of foundation. As to the firſt, it has never been proved fully that any acid is neceſſarily generated in fermentation, much leſs that it was carried along with the exhaling vapour, the circumſtances of pungency of taſte, and change of vegetable blues to red, which have been chiefly urged in proof of it, being more probably attributed to the proper qualities of fixed air. As to the ſecond, the alcaline particles might, with equal probability, be ſuppoſed to adhere to, and be carried over by the fixed air, during effervеſcence, as the acid ones; and moreover, the ſolution of Iron in Mineral Waters that contain an unneutralized alkali, prove very plainly, that this cannot be the caſe, as all the acids we are acquainted with attract alkalies ſtronger than they do metals.

Dr. Lewis has related an experiment* very much to the point in queſtion, although he does not ſeem to have been ſufficiently aware of the cauſe why the Iron was not immediately precipitated. But, in order to render this more clear, I made an * experiment, wherein it was neceſſary that the acid, had there been any, muſt neceſſarily have come into contact with an alkali, before it reached the Iron; and from

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* *Neumann's Chem. p.* 176. If equal quantities of green vitriol, and the mineral alkaline ſalt, or baſis of ſea ſalt, be dropped into a ſtrong bottle filled with ſpring water, and the mouth inſtantly cloſed, ſo as to leave no vacuity in the veſſel,

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veſſel, the two ſalts will be ſlowly diſſolved, and ſubſiſt quietly together as long as the veſſel is kept cloſely ſtopped, there being no room for the extrication of the air, which all acids expel from alkalies, on uniting with them, and without the expulſion of which they cannot unite with them. As ſoon as the bottle is opened, the ſalts begin to act upon one another, and the liquor exhibits the ſame remarkable phænomena as the chalybeate waters do when brought up into the open air. It ſparkles, or emits bubbles of air, taſtes briſk and ſpirituous, as it is called, gives marks both of acidity and alkaleſcence, ſtrikes with galls not the black that vitriol does by itſelf, but a fine purple. On ſtanding for a little time it loſes theſe qualities, the vitriol is deſtroyed, its iron falls to the bottom in form of ochre, its acid being abſorbed by the alkali. The remaining liquor evaporated leaves only a little cathartic ſalt, and a part of the alkali unneutralized, together with a portion of marine ſalt, and different earths which the ſpring water contained before.

* To four ounces of water was added a drachm of lixivium tartari, (which I choſe as the mildeſt alkali,) and the ſolution poured into a vial upon half an ounce of ſteel filings. The whole were then ſhaken until all the filings had ſubſided, and on the ſurface was driven a ſtream of air from an effervescent mixture, the liquor was then filtred, and gave a deep black with ſolution of galls. On addition of a few drops of any acid, a ſtrong effervescence enſued with the alkali.

from this experiment I found the ſame effects, *viz.* the iron was diſſolved, and the alkali not ſaturated. I found, likewiſe, that the air ariſing from * putrefying ſubſtances, and even the † human breath had this effect in a conſiderable degree.

It would be curious to examine the effects of fixed air, produced from various effervеſcing ſubſtances, as I cannot help ſuſpecting that their effects would be very different in this way. Such an enquiry would exceed the limits of a Work of this kind, and farther than as relative to foſſile ſubſtances, would be foreign to the ſubject.

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[*] Eight ounces of ox gall were put into a quart bottle with a communicating tube with a bottle containing four ounces of diſtilled water, and half an ounce of iron filings, and ſet in an open place. After ſtanding two days a ſmall portion was filtred off, but it gave no colour with galls; but on the next day, when the fermentation in the gall became more evident, another portion ſtruck a deep roſy red colour. I obſerved, that on the fifth and ſixth days, when the gall became intolerably putrid, that though the vapour ſtill corroded the iron filings, it had, in a great degree, loſt its power of rendering them ſoluble in water. Does not this favour the opinion, that the vinous fermentation always precedes the putrefactive?

[†] By means of a blow pipe I conveyed my breath near ſix minutes in exſpiration through four ounces of water, in a vial, with half an ounce of ſteel filings; I then filtred the liquor, and on addition of tincture of galls, it ſtruck a deep roſy red colour.

I have not been able to diſcover which of them is the moſt powerful diſſolvent, but ſhall juſt mention a difference in their effects.

I find the air produced from the vitriolic acid, and the foſſil alkali, produces a blacker tinge with the ſame quantity of Iron, on addition of an equal quantity of tincture of galls, than that got from magneſia and calcareous earths, which gave rather a purple caſt; whilſt the breath, putrefaction, and fermentation, gave a roſy red colour. If the various colours which the different kinds of air got by effervеſcence of foſſil ſubſtances with the vitriolic acid give on addition of galls to chalybeate ſolutions, formed by their means, were accurately noted, it would throw great light on our examination of Mineral Waters.

I cannot, neverthеleſs, agree in opinion with that Gentleman, that fixt air is, in general, requiſite to the impregnation of Chalybeate Waters, or that all the fugitive impregnations of this kind are formed by theſe means. I myſelf have ſeen a ſtrong chalybeate impregnation, as volatile as any native one, artificially given to diſtilled water, merely by infuſing in it a ſandy ſubſtance found at the bottom of a ſpring, and which was brought up by the ſtream; and I have been well aſſured that this circumſtance is not uncommon.

As fixt air is ſo powerful a ſolvent for Iron, it ſeemed likely that the vapour ariſing from a ſolution of metals* in acids (particularly of Iron in the vitriolic acid) which reſembles, in ſome meaſure, fixed air in the manner of its production, and which we ſee ſo frequently preſent in the bowels of the earth in form of an inflammable exhalation, might have ſome effect in promoting the ſolubility of metals in water, but I cannot diſcern any ſuch effects, on examination.

On the whole, then, it ſeems probable, that the native chalybeate impregnations of Mineral Waters may be of five kinds.

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* Two ounces of oil of vitriol, diluted with ſix ounces of water, were poured on two ounces of iron filings, in a pint bottle, communicating, by a bent tube, with another containing four ounces of water, and half an ounce of iron filings. The vapour paſſed over in great quantity near twenty minutes, on the ſurface of the water, containing the iron filings, which was then filtred, and to it added a few drops of tincture of galls, but no black or purple colour was produced.

Iron combined with	Saline Bodies.	Acids.	1. Fixt Vitriolic Acid.
			2. Vol. Vitr. Acid.
	Inflammables.	Sulphur in compoſition.	3. Hepar Sulphuris with an Alkali.
			4. Hepar Sulphuris with Quicklime.
	Aërial Bodies.		5. Fixt air from divers ſubſtances.

LEAD.

Lead.

Lead is very rarely, if ever, found native in the earth in its metallic form, being almoſt conſtantly united with Sulphur, in form of an ore. In this ſtate it is not acted on by any menſtrua whatever, nor indeed do any of the foſſil kind, except the vitriolic acid, affect it in its metallic ſtate; and even this has no effect in that way, unleſs aſſiſted by a boiling heat. It may, therefore, be ſafely excluded from the liſt of native impregnations of Mineral Waters.

TIN.

Tin.

This metal is very ſeldom found native in the earth in a ſtate capable of being

acted

acted upon by acids. The vitriolic acid does not diſſolve it, except when concentrated and of a boiling heat, and when again diluted the Tin is precipitated. Hepar ſulphuris likewiſe diſſolves Tin, and renders it ſoluble in water, but not unleſs added to the metal whilſt in fuſion. No other foſſil ſaline body has the leaſt effect upon it. It never, therefore, can enter into the compoſition of any Mineral Water.

SEMI-METALS.

MERCURY.

Mercury. Mercury is ſometimes, though rarely, found native in the earth in a fluid form. In this ſtate it is ſoluble in the vitriolic acid, but not unleſs concentrated and aſſiſted by heat, which are two circumſtances not to be expected to occur below the earth. Hepar ſulphuris, likewiſe, does not affect it, unleſs accompanied with heat. No other of the foſſil menſtrua affect in the leaſt. There are ſome accounts of Mercury flowing out with the current of ſprings in its native form, but I know not if they are to be relied on.

But even in this way, granting the fact to be truly related, it did not form an impregnation of the ſpring. Its general appearance is in form of Cinnabar united with Sulphur, in which ſtate it is totally inſoluble in all menſtrua whatever. It muſt, therefore, be excluded.

BISMUTH.

This metallic ſubſtance is not diſſolved by any of the foſſil menſtrua, and cannot, for that reaſon, ever impregnate a Mineral Water. Biſmuth.

ZINC.

This ſemi-metal is ſometimes met with in a cryſtalline form in the earth, united with the vitriolic acid. Nor is this to be wondered at, ſince it precipitates all metals, even Iron, though of this laſt circumſtance, when that metal is united with the vitriolic acid, Neumann ſeems to doubt. In this ſtate it is ſoluble in water, and may, doubtleſs, be an ingredient in the compoſition of Mineral Waters. A great Chemiſt is of opinion, that it occurs in this man- Zinc.

ner oftener than is imagined, and that its not having been noticed by the Chemiſts was not ſo much owing to its abſence, as to their not having had it in view. Neumann, indeed, mentions it as contained in ſome Mineral Waters, but brings no experiment in proof of it. None of the other foſſil menſtrua affect it in the leaſt; nay hepar ſulphuris, even in fuſion, does not act upon Zinc.

Form in which ZINC *is contained in Mineral Waters. United with the Vitriolic Acid, in form of* WHITE VITRIOL.

ANTIMONY.

Antimony. This metallic ſubſtance is never found native in its reguline or pure ſtate, being always combined with a portion of ſulphur, which defends it from the effect of acids. Alkaline ſalts, indeed, abſorb its ſulphur, and form therewith a compound capable of diſſolving it. This, however, cannot happen, unleſs a greater degree of heat was employed than water is capable of receiving. It is doubtful if the vitriolic acid acts at all on the crude Mineral, but this we may be certain of, that it never can, by means of that ſolvent, impregnate a Mineral Water, as the vitriolic acid does not diſſolve it unleſs when concentrated, and when again diluted lets it fall entirely. No other foſſil ſaline ſubſtances affect it in the leaſt; it may therefore be ſafely excluded.

ARSENIC.

Arſenic.

This, though generally arranged under the head of the Semi-metals, ſeems to incline rather to the ſaline kind, as it diſſolves entirely in water. On this account, and as it is ſo frequently preſent in the earth, we might expect to ſee it ſometimes preſent in Mineral Waters.

But on more accurate examination, it appears to be ſoluble in water only when deprived of its phlogiſton, and when that is reſtored, it is inſoluble. Happily, when native, it is always found combined with Sulphur, in which ſtate it is not acted on by any menſtrua; and we find by experiment, moreover, that if a ſmall quantity thus combined ſhould be accidentally received into the human body, it could produce no bad conſequences.

Arſenic has been ſaid to be found in the Waters of Chevron, or Bru; but on examination, this appeared to be only a report founded on intereſted motives, in order to raiſe the credit of ſome neighbouring Mineral Waters at their expence.

It may then be ſafely excluded from the catalogue of native Impregnations.

REGULUS *of* COBALT.

Regulus of Cobalt.

This metallic body is little known; when native it is always found in a ſtate of union with ſulphur and arſenic, which made it long imagined to be an ore of the latter of theſe. It is now found, however, to be a Semi-metal *ſui generis.* In the ſtate it is found native, it is not acted on by acids, or any foſſil menſtrua, and of conſequence can never impregnate a ſpring.

NICKEL.

Nickel.

This body is never found native free from Sulphur, it attracting that ſubſtance ſtrongeſt of any metallic body known. When in this ſtate, it, like other metals, does not yield to any menſtrua, and of conſequence can never be found in Mineral Waters.

All the metallic Impregnations of Mineral Waters may be reduced to the following.

Baſe Metals.	Copper.		1. Vitriolic Acid in form of Blue Vitriol.—Q. Is Copper ever found combined with the Vol. Vitriolic Acid? I think not, as it is always eaſily cryſtallized from the Waters that contain it.
	Iron.	in a ſtate of ſolution by	2. Fixt Vitriolic Acid, in form of Green Vitriol. 3. Volatile Vitriolic Acid, as in many Chalybeates. 4. Hepar Sulphuris, with an Alkali. 5. Hepar Sulphuris, with Quick-lime. 6. Fixt Air from various Subſtances.—Q. If theſe form different kinds of Chalybeates?
Semi-Metals.	Zinc.		7. Vitriolic Acid, in form of White Vitriol.—Q. If ever united with the Volatile Vitriolic Acid? I think not, for the reaſon given above concerning Copper.

CHAP. VI.

EARTHY IMPREGNATIONS *of* MINERAL WATERS.

IN ſpeaking of theſe bodies, I ſhall, in the firſt place, treat of the various kinds of earths in their ſimple ſtate, and then as combined with ſuch foſſil ſubſtances as render them ſoluble in water*.

Inſolubility in a watery menſtruum has been eſteemed a general characteriſtic mark of earthy bodies in their ſimple ſtate. But I cannot think this well founded, ſince one kind of them, in the moſt ſimple ſtate in which we can procure it, is largely ſoluble, and in fact ſeems to owe its inſolubility only to its being, in ſome degree, in a compound ſtate, and to its union with a body no ways eſſential to it, as an earthy ſubſtance. Moreover, if the theory of an ingenious Gentleman be well founded, it is likewiſe ſoluble when the ſame ſubſtance is united with it in over proportion.

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* Theſe laſt, as bearing the characteriſtic marks of ſalts, might be referred to the head of Saline Impregnations, but I rather choſe to confine that term to the ſimple Saline Subſtances, and thoſe compound ſalts which are properly called neutral, and are formed by the union of the ſimple Saline Subſtances, and to conſider the metallic and earthy ſalts under ſeparate heads.

The firſt of theſe facts is well known to be true; and how far the latter opinion is ſo, I ſhall ſoon proceed to enquire.

SECT. I.

SIMPLE EARTHY SUBSTANCES.

Simple earthy ſubſtances are generally thought to be of four kinds.

I. Abſorbent. III. Argillaceous.
II. Cryſtalline. IV. Talcy.

ABSORBENT EARTHS.

Abſorbent Earths are of two kinds,

1. Calcareous.
2. Magneſia.

CALCAREOUS EARTH.

Calcareous Earth.

The firſt of theſe, in the ſtate we generally ſee, it is united with ſuch a portion of fixed air, as renders it totally inſoluble in water. Nevertheleſs, when deprived of this ſubſtance, either by calcination, (which is the moſt common method,) or by other means, it becomes entirely ſoluble in that menſtruum; though, indeed, but in ſmall proportion to the bulk of water neceſſary for its ſolution.

It has been generally imagined, that calcareous earths, in the ſtate they are found when native foſſil ſubſtances, are united with ſuch a quantity of fixed air, as prevents their ſolution in water; and this opinion appears to be, in general, true. I am, nevertheleſs, well ſatisfied, that there are ſeveral exceptions, and that all thoſe ſtones, of which a conſiderable part is *ſoluble in acids, and which are, when firſt dug from the quarry, very ſoft, and afterwards harden in the air, owe the two laſt qualities to the Calcareous Earth which they always largely contain, and which ſeems to be the bond of union of the other parts, being, in ſome degree, in a

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* The ſolubility of a conſiderable part of theſe ſtones in acids, is a neceſſary circumſtance to be taken in, as ſome of the ſteatitæ are ſoft when firſt dug, and afterwards harden in the air. Theſe, however, being of the argillaceous kind, do not diſſolve in acids.

cauſtic ſtate, or not united with its full portion of fixed air, which the learned Mr. Macbride has, with great probability, imagined to be the uniting principle of the Calcareous Earth itſelf. The hardening of theſe ſtones on expoſure to the air, is moſt probably owing to their attracting fixt air from the atmoſphere.

I find, by experiments * made on ſeveral ſtones of this kind, that, when freſh dug, they impart an earthy impregnation to water, poſſeſſing, in a conſiderable degree, a taſte ſimilar to that of a ſolution of lime, only wanting much of the empyreumatic flavour, from which, nevertheleſs, it was not entirely free.

It appeared, moreover, capable of acting, in the way of ſolution, upon ſulphur very powerfully, as lime does; and the hepar ſulphuris made by means of it, exhibited the ſame appearances with an artificial ſolution of ſulphur in water, made with quick-lime.

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* It was thought unneceſſary to ſet down the experiments at length here, as it will be neceſſary to mention them again, when we come to treat of the Impregnations of the Bath Waters.

I am, therefore, well ſatisfied, that Calcareous Earths may be thus found contained in Mineral Waters.

It has been hitherto generally imagined, that Calcareous Earths were ſoluble in water, only in conſequence of their being in a cauſtic ſtate, or deprived of their fixed air. But in oppoſition to this opinion, the ingenious Mr. Cavendiſh, to whom the literary world are greatly indebted for his curious reſearches into this branch of knowledge, has brought ſeveral very plauſible arguments, to prove that Calcareous Earth may be rendered ſoluble in water, by being united with an over proportion of fixed air, as well as by being deprived of it altogether.

This opinion, though quite contrary to that hitherto received, ſeemed farther ſtrengthened by a ſubſequent diſcovery, that fixible Air poſſeſſed a power of rendering other ſubſtances ſoluble in water, as it is now found to be a powerful menſtruum for iron. Notwithſtanding this great authority, I hope I may be pardoned if I preſume to diſſent, as I acknowledge that Gentleman's Experiments, in order to prove this, though highly worthy attention, did not appear clearly to me to lead to that concluſion. I am, nevertheleſs, well ſatisfied, that many powerful arguments may be urged in favour of that hypotheſis; and though the experiments I have myſelf made did not (as far as I can judge) favour that opinion, I do not ſo far flatter myſelf, as to think they amount to prove the contrary of what Mr. Cavendiſh has advanced, but would have them underſtood rather as a plea in behalf of my doubt of an opinion ſupported by ſo great authority. The limits of this work will not admit ſo full a diſcuſſion as the ſubject would require, particularly that of conſidering, in detail, each experiment made by that Gentleman, and the concluſions thence deduced, in order to prove this point. I ſhall therefore only put down ſome expeririments of my own, relative to the ſubject, and ſubjoin a few obſervations.

EXPERIMENT I.

Ten ounces by weight of lime water, made by pouring diſtilled water on three ſeveral portions of freſh quick-lime, were put into a glaſs decanter, and expoſed to the fumes of an efferveſcent mixture, (compoſed of chalk and the vitriolic acid,) conveyed on the ſurface of the water, by means of a bended tube, reſembling that uſed in Mr. M'Bride's Experiments, and having the junctures ſecured with a piece of bladder, tied with a waxed thread. The vitriolic acid was poured upon the chalk, by means of a funnel inſerted into a ſmall opening made in the ſide of the bottle, which was immediately afterwards cloſed, ſo that very little of the fixed air eſcaped. In a few moments a plentiful precipitation of a flocculous matter appeared, which continued near half an hour, and then gradually ceaſed, and the liquor above became quite clear. Several freſh ſtreams of air, generated by adding freſh quantities of vitriolic acid to the chalk, were then conveyed on its ſurface, but no new precipitation could be perceived. On ſtanding cloſed up, the ſediment appeared to diminiſh in bulk, but on cloſer inſpection it ſeemed evidently owing only to the precipitated particles becoming more condenſed together. Not the leaſt appearance of rediſſolution could be perceived, although the bottle was ſhaken, and the ſediment ſtirred up, and repeated ſtreams of air driven on the ſurface of the liquor.

N. B. This experiment was tried with the air ariſing from the efferveſcence of ſpirit of nitre, of ſpirit of ſalt, and of vinegar, with chalk, and of ſpirit of vitriol, and of ſpirit of nitre with lixivium tartari; and the ſame effect was found to be produced by them all.

EXPERIMENT II.

After the precipitation mentioned in the laſt experiment had fully ſubſided, and the fluid above clear, as much of the liquor as could ſafely, without diſturbing the ſediment, was decanted off, and the remainder evaporated with a gentle heat, ſo as to leave the reſiduum perfectly dry. It appeared to be a white inſipid powder, weighing exactly twelve grains. The liquor poured off was about eight ounces, had loſt all the aſtringent taſte of lime water, but retained ſomewhat of the empyreumatic flavour.

EXPERIMENT III.

To ſix grains of the above mentioned reſiduum was added a drachm of ſpir. nitri, diluted with half an ounce of water. A violent effervefcence enſued, and in a ſhort time the precipitate was entirely diſſolved.

EXPERIMENT IV.

To an ounce of the clear liquor decanted from the reſiduum, mentioned in Experiment II. was added two drops of ſpirit of nitre. Not the leaſt effervefcence enſued.

EXPERIMENT V.

To an ounce of the ſame liquor was added two drops of the freſh expreſſed juice of the cyanus. No more change of colour was obſerved than from diluting it with the ſame quantity of diſtilled water.

EXPERIMENT VI.

The remainder of the liquor, being about ſix ounces, was ſet in an open glaſs veſſel ſeveral days in a chamber window, expoſed to the ſun and air. It loſt, by degrees, all its empyreumatic taſte, but not the leaſt precipitation could be diſcovered. It was then entirely evaporated by a gentle heat, but did not leave more than about a grain of reſiduum, which was of an aſh colour, and not entirely ſoluble in acids.

EXPERIMENT VII.

Ten ounces (by weight) of the ſame lime-water with that mentioned in Experiment I. were evaporated to dryneſs in a china baſon over a lamp. The reſiduum weighed exactly fifteen grains, and reſembled in all reſpects that precipitated by fixed air.

EXPERIMENT VIII.

Sixty grains of chalk, which had been previouſly levigated and waſhed in ſeveral waters, was added to ten ounces of diſtilled water, in a large clear vial. I then inſerted into the neck of the vial a tin tube, the end of which deſcended two inches below the ſurface of the liquor, and the other end was fixed into a bottle containing an efferveſcent mixture of lixiv.

tartari and ſpirit of nitre*. The junctures were previouſly ſecured by bladder, and the bottle, containing the chalk, was ſhaken gently, ſo that the powder was diſperſed through the liquor. Not the leaſt ſign of any ſolution could be perceived, nor did the chalk appear, on its ſubſidence, to be diminiſhed in quantity, though repeated ſtreams of air were introduced.

EXPERIMENT IX.

I decanted off clear about eight ounces of the water from the chalk mentioned in the laſt Experiment, as ſoon as it had perfectly ſubſided, and evaporated the remainder. The chalk appeared unaltered in all reſpects, being quite inſipid, totally ſoluble in, and efferveſcing with, the nitrous acid, and only diminiſhed in weight two grains. The decanted liquor had acquired a briſk vinous taſte.

EXPERIMENT X.

To one ounce of the liquor decanted off in the laſt Experiment, I added four drops of ſpirit of nitre. Not the leaſt efferveſcence appeared.

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* The ſame efferveſcing mixtures were tried with this as with lime-water.

EXPERIMENT XI.

To about an ounce of the ſame liquor I added two drops of the freſh expreſſed juice of the cyanus, but no more change of colour could be perceived than what happened from the dilution.

EXPERIMENT XII.

The remainder of the liquor, now reduced to five ounces, was ſlowly evaporated, but left ſcarce any reſiduum. What there was, was of a grey colour, and was probably only ſome accidental duſt that it had attracted.

By the firſt of theſe Experiments it appeared, that a certain portion of fixed air precipitated the earth from the limewater, but on adding a freſh portion none could be diſcovered to be re-diſſolved.

I repeated this Experiment with ſeveral acids, and with alkaline ſalts as well as earths, not only to aſcertain the ſimilarity of effect of the air produced by each, but alſo to take off the objection if the vitriolic acid only had been uſed, that part of it, during effervеſcence, might have been forced over into the lime-water, and, by uniting with the earth, formed a ſelenites, which might have been ſuſpected, on account of its little ſolubility in water, to have given occaſion to the precipitation. This, however, is fully obviated by the uſe of the nitrous and muriatic acids, as the compounds theſe earths form with the nitrous and muriatic acids are extremely ſoluble in water.

On comparing the ſecond, ſixth, and ſeventh of theſe Experiments, it ſeems pretty clear that the whole of the earth was precipitated from the water. Somewhat of the diſtinguiſhing empyreumatic flavour, indeed, remained, but this, I am well ſatisfied, was owing to ſome oily ſubſtance, from which ſcarce any water can be got entirely free, and not neceſſarily dependent on the earthy impregnation.

Some degree of a taſte of this kind often attends water freſh diſtilled, which water, nevertheleſs, when evaporated, leaves no perceptible reſiduum.

Experiment III. farther proves that the precipitation was an abſorbent earth, ſince ſelenites does not diſſolve in ſpirit of nitre.

Experiment IV. in my opinion, proves that none of the calcareous earth was diſſolved in the water by means of being united with an over proportion of fixed air. Had this been the caſe, an efferveſcence ought to have appeared, which, indeed, being no more than the evolution of the air bubbles, occaſioned by the ſtronger attraction of the acid than of the fixed air to the earth, ought in this caſe to be more remarkable, as the earth was united with a ſuperabundant portion of air.

On this principle, all thoſe waters that leave a calcareous earth on evaporation ought to efferveſce ſtrongly with acids, which I find by experience not to be the caſe. Thoſe waters which ſhould ſeem moſt favourable to ſuch an experiment would be thoſe of the petrifying kind, which depoſit ſpontaneouſly their calcareous earth. But theſe I have not had an opportunity of examining.

Experiment V. farther proves, that the water had loſt one of the great diſtinguiſhing marks of its containing a calcareous earth in ſolution.

Experiment VIII. is made with a calcareous earth ſaturated with fixed air, and ſuch as the water might be expected to meet with in its paſſage under ground.

In this Experiment the air was made to paſs through the body of the water, and to be applied more immediately to the earth, than in the Experiment with lime-water, where it only came on the ſurface; nevertheleſs, no more ſigns of ſolution appeared than in the former Experiment with lime-water analogous to it.

The remainder of the Experiments will be eaſily underſtood, by comparing them with the former experiments made, correſponding to them upon lime water.

I have thus laid down the reaſons which incline me to doubt in a great meaſure if Mr. Cavendiſh's ingenious hypotheſis be well founded. Whether they are juſt or not, I leave others to determine, but cannot help myſelf thinking them of ſufficient weight to deſerve attention, and induce farther enquiry into the foundation of the opinion.

I beg leave farther to obſerve, that a calcareous earth being found in the reſiduum left by waters on evaporation, is by no means a certain proof that it exiſted previouſly in them in an unneutralized ſtate, as ſome have imagined. Dr. Percival has proved beyond a doubt, that all waters containing ſelenites, depoſit, on boiling, a calcareous ſediment, owing to the decompoſition of the ſelenitic ſalt, by heat applied to it in ſolution, the acid flying off, and leaving its earthy baſis behind; and he found, likewiſe, that in conſequence of this ſeparation, the water loſt, in a great degree, its hard qualities, and acquired the power of uniting, in ſome meaſure, with ſoap. The want of this laſt quality could never be attributed to the preſence of the calcareous earth in an unneutralized ſtate. Moreover, the waters thus examined, gave not the leaſt ſigns of containing fixible air, or depoſited the leaſt ſediment on ſtanding. It is likewiſe found, that by long boiling the alkaline baſis of ſome neutral ſalts is convertible into an earthy ſubſtance. Thus we ſee the common table ſalt we uſe almoſt always containing either a portion of an earthy ſalt, or having a portion of unneutralized earth adhering to it, and generally both. This is well known to be owing to the change induced on the alkali by great heat and long boiling, as the water, or brine, from which it is got, when ſlowly evaporated, is not found to contain any unneutralized earth, or earthy ſalt. On this principle depends the ſuperiority of the foreign ſalts, that of the Iſle of May in particular, to the Engliſh.

Such are the grounds for my doubts of the foundation of Mr. Cavendiſh's ingenious hypotheſis. I muſt, however, repeat, that all I mean to inculcate is, the neceſſity of a farther enquiry. I once intended to have conſidered it more largely in this place, but found the ſubject ſo copious, as not to admit of inſertion at length. I therefore determined to put down no more than what my own experience had led me to imagine, and I hope that what has been ſaid on this ſubject, though far from amounting to proof, will, nevertheleſs, authorize me in declaring my doubt of the poſſibility of this impregnation.

This earth is never found native in its ſeparate ſtate in Mineral Waters being not ſoluble in water. Magneſia, though it unites eaſily with fixed air, does not become cauſtic by being deprived of fixt air, like calcareous earth; in compound form it frequently occurs, as will be ſoon taken notice of; but in its ſimple ſtate is incapable of any permanent union with water. It may then be ſafely rejected from the catalogue.

Theſe in their native ſtate are not acted upon by any known menſtruum. When fuſed with an alkaline ſalt in large proportion, as of twice, thrice, or even equal weights, they become ſoluble in water. This proceſs, however, is one of thoſe which we could not *à priori* expect Nature to imitate. But this is another caſe, wherein we muſt not too raſhly attempt to ſet bounds to her operations, as there is good reaſon to believe that theſe bodies have been found in ſome Mineral Waters in a ſtate of ſolution. I am nevertheleſs inclined to believe, that this was not brought about by the means abovementioned, as the cryſtalline earth, by that proceſs, appears to be changed into an abſorbent one, and the cryſtalline earths, which have been diſcovered in Mineral Waters by Mr. Pott and Magraaf, appeared in their original form. But all the impregnations of this kind hitherto diſcovered are ſo ſlight as not to come under the definition of Mineral Waters, and of courſe not comprehended in the preſent intention.

With reſpect to theſe there is great doubt whether or no they are primitive earths; ſome experiments lead us to think them to be a compound, conſiſting of a cryſtalline and calcareous earth. But as this point is not fully proved, and as the argillaceous earth, even granting it to be a compound, is ſuch a one as we cannot by any artificial combination imitate, and as it differs conſiderably from the other ſimple earths, it may be conſidered as diſtinct.

Pure argillaceous earth is ſoluble in the vitriolic acid, but the ſolution does not take place except aſſiſted by heat and long digeſtion, and the acid be in a moderately concentrated ſtate. Notwithſtanding the little reaſon there is to expect the concurrence of theſe two circumſtances in the bowels of the earth, ſome Writers have aſſerted the exiſtence of this earth, as well as the laſt mentioned, in a ſtate of ſolution, in Mineral Waters. But as the quantity mentioned to be diſſolved in three ounces, by their own account, is ſo ſmall as not to cauſe any viſible difference, either in appearance or effects, from common water, it may very properly be diſregarded.

Theſe are not the leaſt affected by any known menſtruum, nor is there the leaſt authority that I know of for their being found in any Mineral Water. They may then be very properly rejected from the catalogue.

SECT. II.

COMPOUND EARTHY SUBSTANCES.

The only proper compound ſtate in which earths are found native, and capable of being diſſolved in water, is in a ſtate of union with the vitriolic acid.

The firſt of theſe I ſhall treat of is the union of the calcareous earth with that acid.

SELENITES.

Selenites.

This is by much the moſt general impregnation that has been diſcovered, and indeed is ſo much ſo, as to be almoſt, in ſome degree of it, univerſal. To this impregnation is owing that quality of waters which is commonly called hardneſs, which is given to thoſe waters which have the power of decompoſing, or, as generally termed, breaking ſoap. Other ſubſtances, however, as the vitriolic acid ſeparate, the ſal cathartic. amar. alum, iron diſſolved by an acid, and perhaps fixed air in large quantity, impart the ſame property.

This impregnation, although ſo frequent, is, notwithſtanding, never found but in very ſmall quantity, in proportion to the bulk of water, owing to the very ſparing ſolubility of this ſubſtance.

SPURIOUS GLAUBER'S SALT.

Spurious Glauber's Salt.

This is very often a native ſubſtance, and, on account of its eaſy and plentiful ſolubility, it is frequently found in Mineral Waters. On account of the laſt of theſe qualities, we meet with more degrees of this than of the foregoing impregnation.

It has been before obſerved, that this ſaline body has often been miſtaken for the true Glauber's ſalt, from which nevertheleſs it is eſſentially different, as having an abſorbent earth, called Magneſia, for its baſis, whereas the other has the foſſil alkali.

ALUM.

Alum.

The laſt earthy ſubſtance, that comes under conſideration, is Alum; concerning this there are great diſputes among the learned, whether or no it is ever found impregnating a Mineral Water. It has been urged, on the one hand, that Alum is no native foſſil production, that the ſubſtances from whence it is got, betray no marks of containing it, when newly dug, until they have ſuffered a decompoſition by expoſure to the atmoſphere. Neumann * aſſerts, that Nature affords no perfect alum; and though both he and Hoffman † ſuſpected it to be preſent in ſome Mineral Waters,

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* Vide *Neumann's Chemiſtry*, p. 185.

† Quamvis igitur fateamur nos nunquam in aquis ſoteriis alumen deprehendiſſe, non tamen inficias utimus quod iis in locis ubi uber aluminis in ſubterraneis tractibus eſt proventus, illudque copioſe effoditur fontes eodem imbuti ſcaturiant. *Hoffmanni Opera, tom. quintus, p.* 140.

they could never find any that gave any ſigns of it on cryſtallization. That the auſtere taſte, and precipitation with alkalines, are common to the ſelenites, or hard waters, as well as the aluminous. That it is very dubious, except in accidental circumſtances, if the vitriolic acid is ever found a native foſſil in its ſeparate ſtate, and at liberty to unite with the aluminous earth, and that if ſuch an accidental combination ſhould take place, on its ſolution in water, it muſt ſoon be decompoſed, the phlogiſton, alkaline ſalts, calcareous earth, and magneſia being more ſtrongly attracted by the vitriolic acid than the earth of alum.

To theſe arguments it has been replied, That there is undoubted evidence, that alum has been found in its cryſtallized ſtate in the neighbourhood of green vitriol; that ſome earths and ſlates have a manifeſt aluminous taſte when newly dug, and from which alum is directly elixated, without any previous expoſure to the atmoſphere. That if any air be neceſſary to its production, that is ſufficient which is contained in the interſtices between the laminæ of the ſlate, from whence it is got, which is of that texture as the aluminous matter may be often there plainly diſtinguiſhed. That the cauſe why Neumann and Hoffman could not procure it by ſimple evaporation, was, that there is almoſt conſtantly united with alum an earthy ſubſtance, and ſome metallic matters, which require to be previouſly precipitated before the cryſtallization will take place, as the liquor of itſelf will not ſhoot, but either continue fluid, or, if farther evaporated, would yield only an unctuous maſs. That, with this intent, the Alum-makers always add a quantity of alkaline ſalt, or urine, or ſometimes both, in order to precipitate theſe which obſtruct the cryſtallization. That the objection concerning the vitriolic acid is of no conſequence, as ſome kinds of pyrites, from which ſubſtance it is frequently got, ſuffer a decompoſition by moiſture only, which would be more likely to happen from the additional attraction of the aluminous earth, which is frequently found, as in the aluminous pyrites, in contact with it.

That as to the decompoſition of alum by alkaline, earthy, and metallic matters, it is very probable that this very often happens, as aluminous waters are not near ſo common as we might expect, from the frequency of the component parts of alum in the bowels of the earth; yet, nevertheleſs, either from theſe ſubſtances not interfering with the current of the ſtream before it riſes to the ſurface, or from the quick paſſage of the water over them not allowing time to diſſolve ſufficient of the earth, or metal, to precipitate all the earth of alum; it is very poſſible to ſuppoſe, that impregnations of this kind may ſometimes occur. In the ſame manner we ſee the foſſil alkali, whoſe attraction to the vitriolic acid is ſo ſtrong as to decompoſe every other ſaline compound in which it is contained, many of which occur ſo frequently in the earth, yet is ſometimes found in its ſeparate ſtate in ſprings. If we allow the preſence of the vitriolic acid ſeparate in Mineral Waters, it is eaſy to account for an aluminous impregnation, ſince Dr. Lewis has proved by experiment, that the argillaceous earth is capable of being converted by the vitriolic acid into earth of alum. Nothing more, then, is neceſſary, than to ſuppoſe a ſpring thus impregnated running through a bed of clay. This is confirmed by an obſervation, that aluminous waters are frequently found in the neighbourhood of volcanoes, where the vitriolic acid is ſubject to be often diſengaged by fire from the Pyrites. It ſeems, moreover, probable, that a perfect alum is generated in clays by the action of the fire. Dr. Percival found, that bricks imparted an aluminous impregnation to water, and on that account very properly cautions againſt lining the ſides of wells with brick; and it is not improbable that the aſtringent taſte in ſome of our ſpring waters is owing to this cauſe.

On the whole, then, from the review of the arguments on both ſides, it ſeems to me very clear, that alum is a poſſible impregnation of Mineral Waters, which opinion is farther confirmed by ſeveral actual proofs of its exiſtence there. It muſt therefore be admitted into the catalogue of native impregnations.

CHAP. VII.

AERIAL IMPREGNATIONS *of* MINERAL WATERS.

WE now come to the laſt, though not the leaſt important impregnation of Mineral Waters, *viz.* with Aërial Bodies.— Theſe are generally thought to be of three kinds:

1. Common or Atmoſpheric Air.
2. Fixible or Mephitic Air.
3. Inflammable Air.

COMMON AIR.

Common Air.

This is poſſibly the only kind of air that does not admit of being ſubdivided into ſeveral ſpecies. It may, indeed, be united with ſeveral bodies, but, when collected ſeparate, appears to be of one kind only. Whether this is ever found native in ſprings, remains to be conſidered. The preſence of an aërial fluid in common water, is frequently obvious to our ſenſes, and at all times diſcoverable, by placing it under the exhauſted receiver, when numerous bubbles will immediately riſe through the body of it. Whether this aërial fluid be the ſame with that of the atmoſphere, affords room for a curious queſtion.

Common Air is certainly miſcible with water, as we ſee in the machine for raiſing a blaſt of wind by means of water, which depends on this principle. But in this way the air ſeems to be only entangled in the water, as it quickly eſcapes, though, in all probability, a portion is ſtill retained ſufficient to ſaturate the water, and only ſo much ſeparated as is above that proportion. But what is the ſtrongeſt argument is, that lime water is not precipitated by addition of common water, and when placed under a receiver * emits air bubbles, which cannot be ſuppoſed to be of the mephitic kind, as that having ſo ſtrong an attraction to calcareous earth in a cauſtic ſtate, would unite with it, and precipitate it from the water.

Common Air ſeems frequently to be united in over proportion with the common

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* I never tried this latter experiment, but had it, I believe, from good authority.

water we drink, from its being entangled in its fall from the tube, from whence it flows. This is frequently the caſe in our pump waters, and to this is owing the numerous air bubbles, which we ſo frequently ſee at the bottom of glaſs decanters, filled with water from a pipe. To the ſame cauſe may be imputed the ſparkling appearance of ſome Mineral Waters, which is attributed, though ſometimes with reaſon, often erroneouſly, to fixible air. I have ſeen ſome Mineral Waters which contained the latter ſubſtance in great quantity, and yet exhibited very little appearance of this kind to the eye, when taken up by immerſing a veſſel ſlowly into the ſpring, but when poured out from a bottle ſhewed great ſigns of it. For this reaſon, I apprehend, that where the effects of the waters depend on this quality, that the manner of taking them up from the ſpring, as at Tunbridge and Buxton, would be preferable to a pump. The cauſe of the ſeparation of the fixible air from the water is moſt probably owing to its being attracted by the common Air. It is then very obvious, that by falling from the pipe of the pump, a much larger ſurface of the water muſt be expoſed to the common Air than in the other method, and which, by its being thus mechanically united with the water in its fall, muſt greatly increaſe the opportunity of its uniting with the fixible air, and of conſequence promote the diſſipation of the latter.

It may be perhaps thought, that an impregnation of this kind can ſcarce come within our definition of Mineral Waters. But there is no ſmall reaſon to think, that the preſence even of common air in water is by no means an indifferent circumſtance with regard to its action on the human body; ſince it is found by experience, that water which has been frozen (which ſeems to ſeparate all the air of every kind,) is not fit for the purpoſes of diet, yet the water ſeems to have ſuffered no change, except in this reſpect; and on that account, the ingenious Dr. Percival has, with great probability, referred the ill conſequences which it appears to have on health to this cauſe.

It may be perhaps owing to this, among other circumſtances, that ſpring water becomes fit for ſeveral purpoſes in the mechanic arts, as the ſolution of ſeveral ſubſtances, and even in diet, by being expoſed to the air, which it would not ſerve at its firſt riſe.

If this theory be juſt, it ſhould caution thoſe who are accuſtomed to drink boiled water, to expoſe it a ſufficient time to the atmoſphere, to recover the air which had been ſeparated by the boiling.

It is poſſible that the fixible air in many Mineral Waters ſupplies the want of common air, to render it proper to be taken into the human body.

As to common air being a native impregnation of Mineral Waters, I cannot think it can ſtrictly be eſteemed ſo, although I make no doubt, that it is contained in many of them, as offered to us, either from its being entangled with them, in the way before mentioned, or from their being expoſed in a large ſurface, at their firſt riſe, a ſufficient time for them to acquire of it a certain proportion.

Although then, in ſtrictneſs of ſpeech, it cannot be admitted, yet, as it is almoſt always preſent in them, in the ſtate in which we uſe them medicinally, and as it is not introduced there by any artificial means, it may in this light be accounted a native impregnation.

FIXIBLE AIR.

Fixible Air.

Fixible, or Mephitic Air, is undoubtedly very largely contained in many Mineral Waters. But whatever doubt there may be concerning common air, we can have none, that many Mineral Waters are largely impregnated with fixible air. The ſparkling appearance, joined with a poignant taſte, and exhilarating, and even, if largely taken, intoxicating effects, is a great evidence of this. Chemical experiments farther confirm this inference, which is drawn from their ſenſible qualities. The calcareous earth is precipitated from lime water by admixture with ſeveral waters, when firſt taken up from the ſpring, but if ſuffered to ſtand ſome time expoſed to the air, before the lime water is added, no ſuch effect is obſerved to take place. I have likewiſe remarked, that ſome Mineral Waters, and even their vapour, act very powerfully in corroding iron, which is a quality of fixible air. This is, indeed, ſo likewiſe of the volatile vitriolic acid; but I am rather inclined to attribute it, in many that I have taken notice of, to fixible air, ſince I obſerved that copper, equally expoſed to the action of the water, was not in the leaſt affected. Now fixible air acts very powerfully upon iron, but has not any effect on copper *, whereas the volatile vitriolic acid diſſolves both very plentifully. Moreover, I have ſeen this effect where there was no reaſon to ſuſpect the preſence of the acid, which, though a poſſible, is nothing near ſo frequent an impregnation as fixible air. It is probable that the ancient fountain Salmacis, mentioned by Ovid, was of this nature, and contained fixible air in large quantity, as the deſcriptions of its effects anſwer nearly to thoſe produced by fermented liquors.

Quis ſi faucibus hauſit,
Aut furit, aut mirum patitur gravitate ſoporem.

Plutarch, in his Life of Lyſander, likewiſe mentions a fountain near Haliartus, in Greece, called Ciſſuſſa, in which they ſay Bacchus was waſhed immediately after his birth, as the water is of a bright colour, taſtes like wine, and is very pleaſant; all which qualities are applicable to waters impregnated with fixible air, and I believe to no other impregnation. Herodotus and Polybius mention inſtances of a like kind. It now remains to be accounted for, by what means Mineral Waters become thus impregnated.

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* Vide Note, p. 133.

And here I muſt obſerve, that on the union of all the acids with alcaline ſalts, or abſorbent earths, in their mild ſtate, a conſiderable quantity of this air is diſcharged. If this happens in a place to which the outward air has not acceſs, it remains united with the * water, with which the ſolvent is diluted. On expoſure to the atmoſphere, however, the fixible air riſes in great quantity, in form of bubbles, through the body of the fluid, being powerfully attracted by the common air, which, in the opinion of ſome eminent modern Chemiſts, ſerves as

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* As no decompoſition ſeems to take place except the common air is admitted, it is more probable that the fixible air remains united with the alcali or calcareous earth, as long as the common air is excluded. Vide Experiment, p. 142, Note.

a menſtruum to the fixible. This may account for the impregnation of the compound ſaline ſprings in this manner, as we may ſuppoſe the union of the acid with the alkali, or with the abſorbent earth, to be formed in the earth, which would give occaſion to the ſeparation of the fixible air, which, ſo long as the communication with the atmoſphere was precluded, would remain quiet in the water; but on the ſpring's breaking out, would, in conſequence of its ſtrong affinity with common air, and leſs ſpecific gravity than the water, riſe from all parts of the fluid, in which it was contained. To this might be attributed the ſparkling appearance, pungent taſte, and ſmell of many Mineral Waters. But notwithſtanding the ſpecioufneſs of this theory, it labours under ſeveral objections. Were it true in its full extent, we might expect to ſee waters impregnated with fixible air, in proportion as they contain a greater or leſs quantity of compound ſaline ſubſtance, from which the air had been diſcharged, as in the formation of a neutral ſalt by an acid and an alkali. Notwithſtanding this, we ſee ſeveral ſprings that contain neutral ſaline matter in great abundance, and ſome even to a ſaturated ſolution, very lightly, if at all impregnated with fixed air. This would ſeem at once to overturn the above theory, but perhaps even this admits of an explanation. The ſalts that are found thus, are common ſalt, Glauber's ſalt, and the earthy ſalt, called Sal cath. amar. The firſt of theſe we have great reaſon to believe to be an original ſubſtance, and that its component parts never exiſted native ſeparately in the earth, but that they were originally produced combined in the form we ſee them, viz. common ſalt; and there are ſome reaſons to induce us to think this not improbable of the Sal cath. amar. and Glauber's ſalt.

On ſuppoſition, however, that it might be formed in the earth by the union of an acid with an alcali, the air thus generated might be abſorbed by other foſſil bodies, many of which attract it before the ſpring had acceſs to it, or at leaſt by ſome ſubſtances it might meet with in its paſſage to the ſurface. Were this true, it would account for this circumſtance, as we could not expect to ſee ſprings thus impregnated with air unleſs ſome new ſaline combination was directly formed by ſome of the means above mentioned in the waters.

A ſtill greater difficulty occurs; the foregoing method might ſerve to account for the union of fixed air with Mineral Waters impregnated with truly ſaline, or earthy ſaline bodies; but will not account for its exiſtence in thoſe waters, many of which we ſee contain it in large proportion, which have ſcarce any admixture of theſe ſubſtances, or, indeed, any diſcoverable impregnation.

It is undoubtedly found in many ſprings, where we cannot account for its preſence by any reaſoning drawn from any analyſis of the water. So far, however, we may venture to ſuggeſt, that as this ſubſtance is found frequently native in ſubterraneous caverns, it is probable the ſprings thus impregnated, paſſed through ſome of theſe, where they were united together, which may be eaſily imagined, as they ſeem to have ſome degree of attraction for one another.

The laſt ſubſtance of this kind that remains to be conſidered is,

INFLAMMABLE AIR.

Inflammable Air.

This is produced during the union of of ſeveral metals with acids, particularly zinc and iron with the vitriolic acid. It is likewiſe ſaid to be generated during the ſolution of tin in its proper menſtruum, *(aqua regia;)* and likewiſe by putrefaction. But as the two latter means never occur below the earth, it is needleſs to conſider them. The only two means, then, that we can account for its production, are by the junction of the two firſt mentioned metals with acids. It is very probable, that it may be generated by other means, but thoſe are not yet come to our knowledge.

I know no variety in the kinds of this aërial ſubſtance, whether that produced on addition of zinc to the vitriolic acid varies from that generated when iron is uſed. If Mr. Cavendiſh's ingenious theory, that it is the phlogiſton of metals, be juſt, it ſhould ſeem probable, that it is of one kind only, as all inflammable ſubſtances are found to revive or reſtore the phlogiſton to all metals indiſcriminately.

The ſame ingenious Gentleman has, indeed, delivered it as his opinion, that this ſubſtance is not miſcible with water. If this were once proved, it would be needleſs to conſider it in this place any farther. I agree with that learned Gentleman entirely, in thinking that it does not admit of any intimate or chemical union with water, as both common and fixible air ſeem to do in ſome degree. But nevertheleſs, I find by experience, that it is capable of being mechanically united, or entangled in a watery fluid, ſo as to have a very perceptible effect on its ſenſible qualities. I am well perſuaded of the poſſibility of this ſubſtance * occurring in the ſubterraneous regions, and that it may ſometimes form an impregnation of Mineral Waters. I am greatly inclined to ſuſpect, that it is frequently miſtaken for fixible air. It imparts a ſimilar pungency, but ſeparates ſooner, and the vapour of it does not precipitate lime water in the manner that fixible air does.

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* This appears from the inflammable damps ſo often met with in mines, and other ſubterraneous places, which are only collections of inflammable air.

It is the opinion of a celebrated Chemiſt, that this is not a ſimple ſubſtance, but compounded of fixed air and an acid. Many arguments may be brought in favour of this opinion; but the preſent work will not admit of any diſquiſition not immediately connected with the ſubject. Whether this opinion be well founded or no, is not here very material, ſince it is always met with in the ſame ſtate, as far as we know, below the earth. From its frequency there, and its poſſible miſcibility with water, though that is only in a ſtate of diffuſion, I think it may be properly admitted into the catalogue of native impregnations.

AERIAL IMPREGNANTS *of* MINERAL WATERS.

Common Air,	1. In intimate union. Q. Whether ſolution or mixture?
	2. In way of diffuſion, as when entangled in its fall from a pipe.
Fixible Air,	3. Q. If intimately united by dilution, or mixture, or by diffuſion only?
Inflammable Air,	4. In a ſtate of diffuſion only, as I think.

From the aforeſaid review of the Impregnations of Mineral Waters we find, that they may all be divided into thoſe impregnated with

Saline Bodies.	Simple,	Acid.	1. Vitriolic acid *per ſe.*
		Alkali.	2. Foſſile alkali *per ſe.*
			3. Volatile alkali *per ſe.* — Very dubious.
	Compound,		4. Glauber's Salt.
			5. Vitr. ammon. very dubious.
			6. Common Salt.
			7. Sal ammoniac, very dubious.
Inflammable Bodies.	Oil.	Simple,	8. Oil foſſil *per ſe.*
		Comp.	9. Oil in form of ſoap.
	Sulphur	Simple,	10. Sulphur *per ſe.*
		Compound,	11. Hep. ſulph. with an alkali.
			12. Hep. ſulph. c. calce vivâ.
Metallic Bodies.	Baſe Metals.	Copper,	13. Vitriolic acid in form of blue vitriol.
		in a ſtate of ſolution by Iron.	14. Fixt vitriolic acid in form of green vitriol.
			15. Vol. vitriolic acid, as in many chalybeates.
			16. Hep. ſulph. with an alkali.
			17. Hep. ſulp. with quicklime.
			18. Fixible air.
	Semi-metals.	Zinc.	19. Vitriolic acid in form of white vitriol.
Earthy Bodies.	Simple,		20. Calcareous earth in ſolution, by being deprived of fixible air.
			21. ——— ———, by being united with it in over-proportion.
	Compound—with vitriolic acid,		22. Calcareous, in form of ſelenites.
			23. Magneſia. — Spurious Glauber's ſalt.
			24. Earth of alum — in form of alum.
Aërial Bodies.	Common Air.		25. In ſolution, or mixture?
			26. In diffuſion.
	Fixible Air.		27. Q. In ſolution, diffuſion, or mixture?
	Inflammable Air.		28. Probably only in diffuſion.

Dif-

Different TEMPERATURE *of* MINERAL WATERS.

Beſides the differences that ariſe from impregnations, Naturaliſts make a diviſion of Mineral Waters from their difference of temperature into the *Acidulæ* and *Thermæ.*

The laſt of theſe have been the ſubject of much enquiry among the Philoſophers, and are ſtill very indifferently accounted for. Naturaliſts, finding that the pyrites, on being moiſtened with water, acquired a conſiderable degree of heat, have been willing, from this admixture, to account for both the impregnation and heat together.

Sulphur and iron filings generate heat till more conſiderable; and to this cauſe they would attribute earthquakes, and volcanoes. But there are many objections, hat will deſtroy, or ſuperſede, the firſt heory; for we have accounts of *thermæ* without any degree of impregnation. But even ſuppoſing the heat to be communicated to a neighbouring ſtream that is unimpregnated, we cannot imagine that ſuch a cauſe hould act with ſuch uninterrupted uniformity, for ſuch a length of time, as theſe

ſeem

ſeem to do, ſince even Ætna and Veſuvius have long intervals of ſeeming quietude. For theſe reaſons, a celebrated Profeſſor at Edinburgh ſeems to think, that they owe their origin to a different cauſe, *viz.* to an internal ſubterraneous heat and fire, ſo much ſpoken of by Philoſophers. This circumſtance, he thinks, favours that opinion, and could its exiſtence be abſolutely proved, we might then account for the production of many foſſils, which we perceive to be ſtrongly marked with evidences of ſuch a forming cauſe.

In order to explain more fully what is ſaid in the preceding book, and the two following, I have ſubjoined a ſhort table of Attractions, taken chiefly from that delivered by Dr. Cullen, and printed by Dr. Saunders, in his Syllabus, with ſome few alterations from Dr. Lewis.

This table is to be thus underſtood. The ſubſtance placed at the head of each ſeries has the greateſt attraction to or affinity with that immediately below it; a leſs affinity with the next, and ſo on, to the end of the ſeries; that ſo, if any of the remote bodies has been combined with the uppermoſt one, the addition of any of the intermediate bodies will diſunite them, the intermediate body throwing out the remote one, and uniting itſelf with that placed uppermoſt. Thus in the firſt column of *Acids in general*, a fixed alkali being placed between the *Acids in general* and quick-lime, denotes, that if an acid was united with quick-lime, the addition of a fixed alkali would ſeparate the quick-lime from the acid, the alkali taking its place.

This table is not very extenſive; but, it is hoped, will ſerve the preſent purpoſe of illuſtrating the experiments on Mineral Waters.

TABLE *of* ATTRACTIONS.

I.

Acids in general.

* Phlogiſton.
Fixt Alkali, *cauſtic.*
——— ———, *mild.*
Quick-lime.
Magneſia.
Calc. Earth, *mild*, as Chalk.
Vol. Alkali, *cauſtic.*
Baſe Metals.
Vol. Alkali, *mild.*
Earth of Alum.
Pure or precious Metals.

II.

Vitriolic Acid.

Phlogiſton.
Fixt Alkali, *cauſtic.*
——— ———, *mild.*
Quick-lime.
Magneſia.
Calc. Earths, *mild.*
Vol. Alkali, *cauſtic.*
Zinc.
Nickel.
Cobalt.
Iron *.
Copper.
Silver.
Tin.
Lead.
Mercury.
Vol. Alkali, *mild.*
Earth of Alum.

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* There is ſome doubt concerning the univerſality of the propriety of placing Phlogiſton above Fixt Alkali. It is true of the Nitrous and Muriatic Acid, and probably of the Vegetable, ſince any inflammable ſubſtance will decompoſe any of the compound Salts made with theſe Acids. In the Vitriolic, too, it ſeems to hold, as any inflammable Subſtance will decompoſe Vitriolate Tartar, and form with its Acid a Sulphur; but, on the other hand, Alkaline Salts added to Sulphur, change its nature, and, in ſome meaſure, decompoſe it, as when heat is applied in this caſe, the Phlogiſton flies off ſeparate, and leaves the Acid and Alkali united.

* Iron and Copper vary in their relative Attraction to Acids, according to the difference of heat, or of cold. In the cold, Iron attracts ſtronger than Copper. When heat is uſed, Copper attracts Acids more powerfully than Iron.

III.

Nitrous Acid.

Phlogiſton.
Fixt Alkali, *cauſtic.*
——— ———, *mild.*
Quick-lime.
Magneſia.
Calc. Earth, *mild.*
Vol. Alkali, *cauſtic* *.
Zinc †.
Lead, or Tin.
Iron.
Biſmuth, or Antimony.
Copper ‡.
Arſenic, or Earth of Alum.
Mercury.
Silver.
Platina.

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* Some place Volatile Alkali above Magneſia.

† Sir Iſaac Newton placed them thus:	Dr. Lewis has placed them thus:
Zinc.	Zinc.
Iron.	Iron.
Copper.	Copper.
Silver.	Lead.
Tin.	Mercury.
Lead.	Silver.
Mercury.	

‡ Perhaps Volatile Alkali *mild* ſhould be placed here.

IV.

Muriatic Acid.

Phlogiſton.
Fixt Alkali, *cauſtic.*
——— ———, *mild.*
Quick-lime.
Magneſia.
Calc. Earth, *mild.*
* Vol. Alkali, *cauſtic.*
Zink.
Iron †.
Tin.
Regulus of Antimony.
Copper.
Lead.
Silver.
Mercury.
Gold.

V.

Vegetable Acid.

Phlogiſton.
Fixt Alkali, *cauſtic.*
——— ———, *mild.*
Quick-lime.
Magneſia.
Calc. Earths, *mild.*
Volat. Alkali, *cauſtic.*
——— ———, *mild.*
Zinc.
Iron.
Tin.
Copper, or Antimony.
Lead.
Silver.
Mercury.

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* Perhaps the Volatile Alkali ſhould be placed lower.

† Some place Iron next below Tin.

VI.

Alkaline Salts.

Vitriolic Acid.
Nitrous Acid.
Muriatic Acid.
Vegetable Acid.
Volat. Vitriolic Acid.
Acid of Borax.
Oil *.
Sulphur.

VII.

Calcareous Earth.

Vitriolic Acid.
Nitrous Acid.
Muriatic Acid.
Vegetable Acid.
Fixible Air †.
Sulphur.

VIII.

Fixible Air.

Calces of Metals *.
Quick-lime.
Fixed Alkali.
Magneſia.
Volatile Alkali.

IX.

Phlogiſton.

Nitrous Acid.
Vitriolic Acid.
Metallic Subſtances.
Fixt Alkaline Salts.

X.

Sulphur.

Fixt Alkali, *cauſtic.*
—— ——, *mild.*
Quick-lime.
Iron.
Copper.
Lead.
Tin.
Silver.
Antimony.
Mercury.
Arſenic †.
Volatile Alkali.

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* I imagine Fixible Air ſhould be here inſerted between the Acid of Borax and Oil.

† I have placed Sulphur below Fixible Air, on the authority of Mr. M'Bride, who has found Fixt Air to precipitate Sulphur from a Solution of Hep. Sulph. c. cal. vivâ, though I own I rather doubt it.

* The ſuperior Attraction of Fixible Air to Calces of Metals is ſhewn by a mild Calcareous Earth, being ſufficient to reduce ſeveral of them into their metallic form without the addition of any Inflammable Subſtance.

† Some place the Volatile Alkali between Mercury and Arſenic.

XI.

Lead.

Vitriolic Acid.
Muriatic Acid.
Nitrous Acid.
Vegetable Acid.
Oil.

XII.

Iron.

Vitriolic Acid.
Muriatic Acid.
Nitrous Acid.
Vegetable Acid.

XIII.

Antimony.

Vitriolic Acid.
Nitrous Acid.
Muriatic Acid.
Vegetable Acid.

XIV.

Copper.

Vitriolic Acid.
Muriatic Acid.
Nitrous Acid.
Vegetable Acid.

XV.

Mercury.

Muriatic Acid.
Vitriolic Acid.
Nitrous Acid.

PART

PART II.

HAVING thus determined the nature and qualities of the ſeveral ſubſtances contained in Mineral Waters, I ſhall now give a ſhort ſketch of the moſt approved means to be uſed for diſcovering theſe impregnations.

And here it is not propoſed to attempt an account of the effects of every experiment uſed on theſe occaſions with each of the impregnations, but to ſelect ſuch only as may moſt effectually ſerve to diſcover their contents.

I ſhall take theſe in the order they are preſented in the foregoing Table.

CHAP. I.

SALINE SUBSTANCES.

SECT. I.

SIMPLE.

PART II.

Vitriolic Acid *per ſe.*

WATERS of this kind are ſometimes ſo ſtrongly impregnated as to be diſcoverable to the taſte by their acidulous tartneſs. They change the colour of the vegetable blues to a reddiſh* caſt, efferveſce with all the alkaline ſalts, or calcareous earths, and with † magneſia when theſe ſubſtances are in their mild ſtate, or united with fixible air, and on evaporation, leave a ſalt which has the vitriolic acid for its acid baſis, but which may be either of the neutral or earthy kind, according to the ſubſtances which were added in the experiment.

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* It may be thought extraordinary to make this a teſt of the preſence of the vitriolic acid, which has been before mentioned, as being preſent here in its volatile ſtate, in which it deſtroys all vegetable colours whatever. But I find that this acid, when very largely diluted with water, as it always muſt be in ſprings, becomes in ſome degree fixed, and changes the vegetable blues, red. In diſtilling vitriolic acid, the operators find, that a ſmall quantity of water in the receiver is of ſervice, by rendering the acid more fixed.

† *Vide* Eſſays, Phyſical and Literary, Vol. II. p. 174.

They precipitate all ſolutions made in alkalines, curdle ſoap, or render a ſolution of it in rectified ſpirit milky. A ſolution of ſulphur in water made by means of alkalies is precipitated, and rendered milky by theſe waters, and emits at the ſame time a ſtrong fœtor. Dr. Lewis has mentioned the ſame effect as produced on the ſolutions of ſulphur made by means of quick-lime. This is true of a very ſtrong or nearly ſaturated ſolution of ſulphur made by theſe means, but will not hold good of a dilute one, which is not viſibly affected by acids. They produce a cloudineſs with the ſolutions of ſilver, lead, and mercury, in the nitrous acid; with the two firſt, of a whitiſh colour, (though not in near ſo great a degree as that with the muriatic acid;) and with the laſt, the precipitation ſoon acquires a yellowiſh tinge. Such are the general characters of theſe waters. Some of them, nevertheleſs, are not peculiar. Waters containing alum efferveſce with alkaline ſalts, precipitate the ſolutions of ſilver and lead in a whitiſh cloud, and that of mercury in a yellowiſh one, and change the colour of the vegetable juices.

In order to ſupply this defect, the learned Dr. Lewis recommends to diſtil the water whilſt freſh, and then examine if what comes over in diſtillation has this effect on the vegetable blues. He alledges, that if this be the caſe, we may be aſſured of the preſence of an acid unneutralized, as the neutral or earthy ſalts which produce this effect, do not riſe in diſtillation.

This Theory of the Doctor's is very ingenious, and I wiſh I could pay an entire credit to it, as it would afford an eaſy method of diſcovering the preſence of this ſubſtance in waters. I will, however, venture to ſuggeſt a circumſtance, which makes me doubt if this be ſo clear a teſt as that learned perſon ſeems to imagine.

The ingenious Dr. Percival, in his Eſſay on Water, has demonſtrated, that the vitriolic acid, when the ſalt containing it is in a ſtate of ſolution in water, (as in this caſe might often happen with ſo common an impregnation as ſelenites,) is ſeparable by a boiling heat, and that by theſe means the hardeſt

PART II. hardeſt waters that owe this quality to that ſubſtance, might be rendered ſoft. It is probable, therefore, that this would happen in diſtillation, and the vitriolic acid be thus forced over into the receiver, and impregnate the diſtilled liquor in ſufficient quantity to produce this effect on the vegetable blues, although it had never exiſted originally in a ſeparate ſtate in the ſpring. It is doubtful if the vitriolic acid does not ariſe in a volatile form from ſelenites, which would render this ſtill more probable.

This opinion is confirmed by the appearances obſerved on the diſtillation of ſea water, where a ſmall quantity of the vitriolic acid (which is always preſent in it) comes over into the receiver, unleſs a quantity of fixed alkaline ſalt, or calcareous earth, be added to it, previous to its being committed to diſtillation.

The following ſeems to be the more certain method of determining the preſence of this ſubſtance, *viz.* to obſerve firſt, if the effervеſcence cauſed by addition of mild alkaline ſalts, magneſia, or calcareous earths, and the change of vegetable blues to red, does not ceaſe to be produced on the waters ſtanding expoſed to the air. Secondly, if any precipitation happens on addition of a mild calcareous earth, or magneſia. The firſt of theſe is a pretty certain mark of the preſence of an unneutralized acid, as the vitriolic acid, when in its ſeparate ſtate in Mineral Waters, is always in a conſiderable degree volatile. Were theſe effects produced by alum, or any metallic ſalt, diſſolved in the waters, they would be more permanent in them. If no precipitation happens through the body of the liquor, on addition of a mild * calcareous earth or magneſia, but an efferveſcence enſues without any change of colour, it may be taken for granted, that an acid is preſent in its ſeparate ſtate; as was it united with earth of alum, iron, copper, or any other metallic ſubſtance, ſome precipitation or change of colour would happen on ſuch addition.

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* If this be uſed, care ſhould be taken to uſe it very ſparingly, as the compound ſaline ſubſtance formed, is ſo difficultly ſoluble in water. Perhaps, on this account, magneſia would be the propereſt teſt.

Foſſile Alkali.

Waters containing the foſſil alkali efferveſce with all the acids, and form thus neutral ſalts, according to the different acids added to them, change the vegetable blues to green, and precipitate the ſolutions of calcareous earths, or magneſia, in any of the acids, and of the ammoniacal ſalts and alum in water.

They render milky the ſolutions of ſilver, lead, and mercury, in the nitrous acid, and precipitate the iron from the vitriolic, nitrous, and muriatic, in form of a yellowiſh brown ochre. Dr. Lewis recommends as the moſt certain mark of this ſubſtance, to obſerve if the water containing it effervesces with the muriatic or vegetable acids. This is certainly a good criterion with reſpect to thoſe ſaline bodies into whoſe compoſition the vitriolic acid enters, as theſe would not be decompoſed by addition of the muriatic or vegetable acids, but will not hold univerſally, as waters containing calcareous earths in a diffuſed ſtate (or, if Mr. Cavendiſh's ingenious Theory be true, diſſolved by an over proportion of fixed air,) would exhibit the ſame appearance, although they contain no alkali.

In my opinion the beſt teſt is to examine the reſiduum left by ſuch waters on ſlow evaporation. This, if the foſſil alkali was contained in the water, will be in part ſoluble again in the ſame fluid, and will then, if but a ſmall quantity of water is added, manifeſt itſelf by its urinous taſte, by its change of vegetable blues to green, and by its efferveſcence with acids, which might be not diſcernible when diluted ſo largely as this ſubſtance ſometimes is in Mineral Waters.

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* A precipitation is occaſioned in waters of this kind, by addition of a ſolution of chalk or magneſia in the nitrous or muriatic acids. This circumſtance, joined to that mentioned by Dr. Lewis, affords a

reaſonable preſumption of the preſence of an alkali, as the calcareous earth before mentioned would cauſe no precipitation.

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* Dr. Lewis has ſaid, that ſolutions of calcareous earths in water, lime water for inſtance, decompoſes neutral ſalts, formed by an acid and alkali, *e. g.* Glauber's ſalt, (*Vide Neumann*'s *Chem. p.* 176.) I have repeated this experiment, but always found the contrary effect, as the alkali added to an earthy ſalt, produced a decompoſition; but an earth added to a neutral, produced no change. Glauber's ſalt or vitriolic tartar cannot be decompoſed by any ſimple ſubſtance, but only by a double elective attraction, as in the caſe of ſolution of ſilver in the nitrous acid, and of earths in the nitrous or muriatic.

The Doctor himſelf, in another part of his Work, has confirmed what is here laid down. (*Vide Neumann*'s *Chemiſtry*, *p.* 252.)

SECT. II.

SALINE SUBSTANCES.

COMPOUND.

Glauber's Salt.

Waters containing Glauber's ſalt in large proportion, are eaſily diſtinguiſhed from thoſe that poſſeſs other impregnations, by the bitteriſh ſaline taſte that accompanies them. But it is ſometimes preſent in too ſmall a proportion to be obvious to the taſte. On evaporation, notwithſtanding it is diſcoverable by its chryſtals, which are large and well formed, of an hexagonal priſmatic form, when perfect and truncated at both ends.

They are of very eaſy ſolubility in water, and calcine in a dry air. On evaporation the impregnation manifeſts itſelf to the taſte, though when largely diluted, it was not perceptible. Theſe waters cauſe no change on the colour of vegetable blues, and afford no precipitation on addition of alkaline, or acid ſubſtances, in which they differ from waters impregnated with ſal cath. amarus, which ſhew a precipitation on addition of an alkali, though in other reſpects, as taſte, ſhape of chryſtals, and eaſy ſolubility, they much reſemble this. Solutions of lead and ſilver in the nitrous acid are precipitated in form of a yellowiſh white cloud, and that of mercury in the ſame acid, in an orange coloured one. Moreover, Glauber's ſalt melts eaſily in the fire, whereas the other can ſcarce be fuſed by the moſt extreme heat.

Common Salt.

The brackiſh taſte of many waters frequently diſcovers the preſence of this ſubſtance. It is, indeed, preſent native in moſt ſprings, though not in quantity ſufficient to be thus detected. It differs from the former, by its not having the bitter taſte which accompanies the Glauber's ſalt and ſal cath. amarus. But the ſureſt teſt of it is, to examine the ſhape of the chryſtal yielded on evaporation. Theſe are always cubical, which diſtinguiſhes them from all other native ſubſtances found in Mineral Waters, as none of them aſſume that form on cryſtallization. It is not affected by alkaline ſubſtances, but on ad-

PART II. dition of the vitriolic or nitrous acids, a decompoſition takes place, and the ſalt loſes its native taſte and qualities, and aſſumes thoſe of Glauber's ſalt, or cubic nitre. It precipitates the ſolutions of ſilver, lead, and mercury in the nitrous acid, the moſt ſuddenly and largely of any ſubſtance, in form of a white cloud, which ſoon falls to the bottom, and may be collected by itſelf, and proves to be the muriatic acid of the ſea ſalt, ſeparated from its alkaline baſis and united with the ſilver. It does not affect the colour of vegetable blues.

C H A P. II.

INFLAMMABLE SUBSTANCES.

Foſſile Oil.

THIS comes next in order, and is eaſily diſtinguiſhed by the taſte and ſmell of the waters that contain it, both of them being very acrid, and peculiar to this ſubſtance only. When in this ſtate they are diſtinguiſhable to the eye, the oil not being mixed with the water, but floating on its ſurface. It is generally, when thus found, of a browniſh colour, and thick conſiſtence, when it is called petroleum, though ſometimes it appears clear and colourleſs, when it is termed naptha. Thoſe wells are of this kind that take fire on application of a burning body to their ſurface.

Oil united with water in form of ſoap.

Theſe waters poſſeſs the ſame qualities with the above-mentioned, except that here the foſſil oil is more intimately united with the water by mediation of an alkali. It is diſcovered by addition of acids which immediately ſeparate the oil, and leave the water clear.

Sulphur *per ſe.*

This is diſcoverable by the taſte and ſmell of the waters that contain it; by examination of the precipitate it lets fall on ſtanding, which ſometimes, as at Aix la Chapelle, lines the pipes that convey it. This, if ſulphur, may be eaſily diſtinguiſhed by its taſte, ſmell, and inflammability, by the waters ſtriking a black colour with ſolution of ſacch. ſaturni in water, and ſolutions of lead in the nitrous acid; by their ſudden tarniſhing of ſilver; by the fœtid ſmell, reſembling a rotten egg, or ſcowering

ing of a foul gun barrel, on addition of alkalies; by the taſte attending this addition; all which circumſtances point out this ſubſtance very clearly.

Hepar Sulphuris with an alkali.

The taſte and ſmell of theſe waters are ſo remarkable, as ſcarce to leave any room to doubt the impregnation, when they are preſent. They reſemble, as was ſaid before, a rotten egg, or ſcowering of a gun barrel; in the latter of theſe, this ſubſtance is always generated on the inflammation of the gunpowder, the acid of the nitre being diſſipated, and the vitriolic acid of the ſulphur, joined to the phlogiſton acquired from the charcoal uniting with its alkaline baſis, and forming this ſubſtance.

Waters impregnated thus, ſtrike a black colour with ſolution of lead in the nitrous acid, and with a ſolution of Sacch. Saturn. in water from whence the ſympathetic ink is derived. They tarniſh ſilver ſuddenly and deeply; become milky, and emit a ſtrong fœtor on addition of acids; by which they differ from the laſt mentioned, as the ſulphur being there in a diffuſed ſtate, is not affected by acids. The former, too, is not diſtinguiſhed by the taſte and odour above mentioned, which is peculiar to this.

It differs likewiſe that this, though in part decompoſed by expoſure to the air, and, as Dr. Cullen thinks, by ſolution in water, yet retains its qualities in a great degree, when kept from the air a conſiderable time; whereas, the other ſoon ſuffers a precipitation of all its contents of this kind.

Hepar Sulphuris with Quick-lime.

This, though nearly allied to the former, exhibits very different appearances, on experiment. A weak ſolution, ſuch as we generally ſee in Mineral Waters, is not affected by acids; and though the ſtrong ſolution be diſagreeable to the taſte, the dilute one is not unpalatable, having nothing of that peculiar ſmell and taſte reſembling a putrid egg, or ſcowering of a gun, which ſo eminently diſtinguiſhes the other. It is decompoſed by expoſure to the air, and ſolulution in water, as the hepar. ſulph. with alkali is, and on ſtanding, even ſhut from the air, ſuffers a precipitation. It ſtrikes no black colour with ſolution of lead in the nitrous acid, or of ſacch. ſaturni in water, and ſcarce even precipitates them or the ſolution of ſilver. It is precipitated by all the alkalies both fixed and volatile, which the former is not. It has no effect in tarniſhing ſilver.

CHAP. III.

METALLIC IMPREGNATIONS.

Copper. WATERS of this ſort are ſometimes obvious to the taſte, which is, indeed, able to diſcover a very ſlight impregnation of this kind. Thus we ſee waters that have ſtood in copper or braſs veſſels gain what is called a braſſy taſte, though the quantity diſſolved can ſcarce be meaſured. The moſt certain teſt of the preſence of this metal, is the addition of the cauſtic volatile alkali, as ſp. ſal. amm. cum calce viva. This, if the ſmalleſt particle of copper be diſſolved, cauſes the whole of the fluid to aſſume a beautiful blue colour. Iron alſo precipitates this metal. On addition, therefore, of a plate of iron to any waters containing copper in ſolution, it will ſoon be covered with a cruſt of this metal; and if it be laid in the current of the ſpring, will in time be entirely changed into it. This has given room for ſome, who did not underſtand the nature of precipitation, to imagine that the iron was really tranſmuted into copper; whereas no more happens than the ſimple precipitation of the copper, occaſioned by the vitriolic acids that held it, diſſolved, having a greater affinity with iron than copper. A proportionable quantity of iron is, therefore, diſſolved in place of the copper precipitated, which always happens on the ſurface of the precipitant, ſo that in time the whole is diſſolved, and a portion of copper ſubſtituted in its place. It is obſervable of metals, that they always precipitate each other in their metallic form. If waters contain copper in any conſiderable quantity, it may be diſcovered by cryſtallization.

Iron.

Chalybeate Waters are generally diſcoverable to the taſte by their peculiar aſtringency. Where the quantity diſſolved is very ſmall, this is not perceptible. Springs of this kind are eaſily diſtinguiſhed by the ochrous ſediment which is conſtantly precipitating

Part II. cipitating from them, and which gives a yellow colour to all the ſubſtances expoſed to their current. The principal and beſt known teſt of them is the black colour they ſtrike with the vegetable aſtringents, and a purple one when an alkaline ſalt or lime water is added to the aſtringent. Dr. Percival has aſſerted, that the ferruginous waters will not ſtrike a black or purple with many of the vegetable aſtringents, without the addition of lime water, and has, indeed, brought ſeveral experiments in proof of what he has alledged. The addition, however, of theſe ſubſtances, makes this experiment tolerably ſatisfactory, and enables us to diſcover a very minute portion of iron in the water.

Some of the mineral aſtringents, as alum, likewiſe precipitate this metal in form of a reddiſh yellow ochrous ſediment, which, on addition of an inflammable body, and a ſmall degree of heat, may, like the foregoing precipitation, be again reduced into iron. Zinc is the only metallic ſubſtance that is known to precipitate iron, which it does in form of a browniſh powder. The ſame is ſaid of nickel by ſome,

but

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but this is not proved. It is obſervable, that all the ſolutions of iron by native ſubſtances, as by acids, the two kinds of hepar ſulphuris and fixed air, ſtrike a black colour with vegetable aſtringents. Care muſt be aken to make theſe experiments with the waters when freſh from the ſpring, as on tanding, they loſe theſe qualities.

Varieties of chalybeates.

Green Vitriol.

So much for chalybeates in general. As o the diſtinguiſhing the varieties of theſe, hoſe formed by green vitriol are diſcove- able by their retaining their power of triking black with aſtringents a conſide- able time, by their efferveſcing with mild alcareous earths, and at the ſame time etting fall a brown precipitation, and when argely impregnated, by their exhibiting ryſtals of green vitriol on evaporation. The liquor, likewiſe, when nearly evapo- ated, gives a red tinge to the vegetable lues.

With vol. vitriolic acid.

Thoſe formed with the volatile vitriolic cid, are diſtinguiſhed from the former by he quick precipitation of the iron from hem, and from thoſe formed by fixible air, by the effervefcence* obfervable on addition of calcareous earth, or magnefia, in a mild ftate, which does not happen in chalybeates of the latter kind.

With hepar fulph. with an alkali.

For the diftinction of hep. fulphur. with an alkali, *vide* chap. on inflammable fubftances, Book II. Chalybeates formed by thefe means give no ochrous precipitation on addition of an alkaline falt.

With hepar fulphuris with quick-lime.

Chalybeates of this kind are diftinguifhed from the foregoing, by their giving an ochrous precipitation, with cauftic alkaline falts, but none with lime-water. For the method of difcovering this kind of hep. fulph. *vide* chap. on Inflammables.

With fixible air.

Thefe chalybeates are diftinguifhed by their quickly lofing their qualities when expofed to the air, by their fhewing no effervefcence with mild alkaline falts, and by the other marks which indicate the prefence of fixible air, for which *vide* chap. V. of this Part, on the means of difcovering Aërial Impregnations.

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* In this cafe a precipitation happens, but the iron is fometimes re-diffolved by the fixible air, fet loofe from the earth by the acid.

Thi

Zinc.

This ſubſtance has hitherto been ſo little uſpected to be preſent in Mineral Waters, hat we have had very few experiments nade on the appearances it aſſumes on ad-lition of other bodies. It is always ound in Mineral Waters diſſolved by the vitriolic acid in form of white vitriol. It nay be diſcovered on cryſtallization by its aſte, which is nauſeous, ſweetiſh, and typtic, and by the form and colour of its ryſtals, which are pyramidal, parallelo-pipeds, and ſometimes tranſparent, though generally of a duſky yellowiſh hue, from the ochre of iron they contain in the ſtate we find them. Moreover, if any of the ſuſpected cryſtals be mixed with equal weight of calcareous earth, and double their weight of charcoal duſt, made into a paſte with oil, put between two plates of copper, and then placed in a moderately hot furnace for a ſhort time, the zinc will diſcover itſelf, by changing that part of the copper* into braſs, which comes into contact with it.

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* This muſt be carefully diſtinguiſhed from the whiteneſs communicated to copper by a ſmall quantity of arſenic. They differ in this, that arſenic renders the copper extremely brittle, which zinc does not.—This is only meant as a caution, and not to inſinuate that arſenic was ever known to be found in any Mineral Waters.

CHAP.

CHAP. IV.

EARTHY IMPREGNATIONS.

SIMPLE.

CALCAREOUS EARTHS.

PART II.

Calcareous Earth.

THE calcareous earth is the only one we find in its ſimple ſtate united with water in quantity ſufficient to bring it under the foregoing definition of Mineral Waters. If this be diſſolved by being deprived of its air, all ſubſtances that ſupply that ſubſtance will precipitate the earth in large quantity. Waters of this kind muſt then be precipitated by all the means that lime water is precipitated, *viz.* by the air ariſing from effervescent mixtures that generated in fermentation, and that emitted from the lungs of animals in breathing. If Mr. Cavendiſh's theory of the ſolution of calcareous earth, by being united with an over proportion of fixible air, be juſt, then the earth will be precipitated by all ſubſtances that attract the ſuperabundant quantity, which, according to that theory, does not appear ſtrongly attached to the earth, although the ſame earth attracts fixible air to a certain proportion, the moſt powerfully of any body we are acquainted with. The addition, therefore, of lime water, or the cauſtic alkali, will precipitate the calcareous earth from the water. If the former be uſed, it will be neceſſary to compute the quantity of earth contained in the portion of lime water which is added, and to ſubſtract that from the reſiduum, ſince the earth contained in the lime water would be precipitated alſo. If the cauſtic alkali be uſed, it might be apprehended that part of the reſiduum might be produced by the decompoſition of ſelenites, which moſt waters contain, and this is true in ſome degree, eſpecially if the alkali be not perfectly cauſtic, which is very difficult to procure. But I find that the precipitation, on addition of ſoap lees to the ſelenitic waters, is very ſmall in compariſon with that let fall when lixivium tartari is uſed, which difference is owing, probably, to the calcareous earth, in the firſt caſe remaining in its cauſtic ſtate, and of conſequence retaining its ſolubility in water; and in the latter, becoming mild and inſoluble in water, and of courſe precipitating by having attracted the fixible air, let looſe from the alkali on its union with the vitriolic acid, which laſt is one of the component parts of ſelenites. But I ſhould think theſe precipitations might be diſtinguiſhed by obſerving if the precipitation on addition of the cauſtic alkali was not larger when the water was freſh, than after it had ſtood ſome time, as the ſuperabundant quantity of fixible air is obſerved to ſeparate from the earth on ſtanding.

If then there be a large precipitation of calcareous earth by cauſtic alkali when the water is freſh taken up, and ſcarce any after it has ſtood ſome time, I ſhould think it a general argument to prove, that it contained calcareous earth in the manner ſuppoſed by Mr. Cavendiſh. If the water contain calcareous earth in form of quick lime, ſuch waters will unite eaſily with ſoap, but whether that would be ſo in the latter inſtance, I have ſome doubt, as fixt air has the power of ſeparating the oil from the alkali, and, it is probable, that in conſequence of this quality, that ſome waters refuſe to unite with ſoap at their firſt riſe, which, after ſtanding ſome time expoſed

PART II.

xpoſed to the air, do it very eaſily.
'his change may, with great probability,
e attributed to the eſcape of the fixible
ir.

'OMPOUND EARTHY IMPREGNATIONS.

Selenites.

This, as before obſerved, is a very fre-
uent impregnation. It is diſcovered by
he refuſal of theſe waters to unite with
pap, and by their throwing down a large
arthy precipitate on addition of a mild
lkaline ſalt. On evaporation, likewiſe, it
s diſtinguiſhable by the form in which it
ryſtallizes, being in thin laminæ, which
orm a pellicle on the ſurface of the liquor,
y the taſte of the ſalts and water contain-
ng them after a pellicle is formed, which
s lightly ſaline and auſtere. We ſhould
owever be cautious not to miſtake the
vaters impregnated thus, for thoſe con-
aining calcareous earths in ſubſtance, as
hey leave nearly the ſame reſiduum on
oiling; by the decompoſition of the Sele-
ites they may be diſtinguiſhed, in that
oth the latter ſoon depoſit their earth, on
tanding expoſed to the air ſome time, which
s not the caſe with theſe waters.

Spurious Glauber's Salt.

This is not liable to be confounded with any other ſubſtance, except the true Glauber's ſalt. The method of diſtinguiſhing them is given above in the account of that ſubſtance.

Alum.

Waters, containing alum, diſcover themſelves, on evaporation, by their auſtere aſtringency. They change vegetable blues to red, and coagulate milk.

The taſte of ſelenites, though rather auſtere, is very diſtinguiſhable from alum, by its inferiority in ſtrength, as the former is very ſparingly ſoluble in water. We have, however, a more certain method of diſcovering the preſence of alum, which is, to evaporate the water until it becomes perceptibly ſaline, when, if we add a few drops of lix. tart. or any other fixed alkaline ſalt, the alum will be precipitated, not as other earths are, (in a powdery form,) but in flocculi. If but a ſmall quantity of alkali is uſed, theſe will be re-diſſolved, which ariſes from the nature of alum, which is the only ſalt we know that has a ſuper-abundant portion of acid adhering to it, which re-diſſolves the earth of alum, precipitated by the alkali. If too much alkali is uſed, the ſuperabundant acid will be ſaturated, and the earth not diſſolved. Dr. Lewis recommends to us to examine with vitriolic acid the precipitates of waters thrown down by addition of alkali. This, if the water contained alum, will unite with the earth thus precipitated into a highly aſtringent ſalt; if it contained magneſia, into a ſaline bitter one; and if a calcareous earth, into one ſlightly ſaline and aſtringent, and ſcarcely ſoluble in water. The cryſtals of alum are hexangular, and of a middle ſolubility, between ſelenites and the true or ſpurious Glauber's ſalt.

CHAP. V.

AERIAL IMPREGNATIONS.

Common air.

THE preſence of air in water has been obſerved before to be proved by the experiment of the exhauſted receiver, which probably ſeparates all ſubſtances of this kind from water. This is diſtinguiſhed from the other two kinds by this, that although it ſeparates from the water on exhauſting, the air does not ſpontaneouſly fly off, nor does it precipitate the lime from lime-water when they are mixed together.

This

Fixible air.

This is diſcoverable by the ſparkling appearance, pungent taſte and ſmell, and intoxicating effects of the waters that contain it. They likewiſe precipitate lime from lime-water on admixture with the latter, and corrode, and even diſſolve iron when freſh taken up, though they loſe both theſe qualities on ſtanding ſome time expoſed to the air. The air likewiſe conveyed from theſe waters by a bended tube on the ſurface of a quantity of lime water will precipitate the lime from it.

Inflammable air.

This ſeparates more eaſily from the water than either of the two foregoing, being of much leſs ſpecific gravity *. It imparts a ſimilar pungency, but I cannot diſcover if it communicates any effects of the inebriating kind ſimilar to thoſe poſſeſſed by fixible air.

Waters of this kind differ from thoſe which contain fixible air, in that they neither diſſolve iron, nor precipitate lime from lime-water, nor is the latter of theſe effects produced by their vapour.

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* Fixible air is heavier than common air, inflammable air is lighter.

P A R T III.

I Come now to the application of the two foregoing Parts, to the inveſtigation of the nature and qualities of the Bath Waters, and the circumſtances in which the different ſprings vary from each other. But before I enter upon the Chemical Experiments neceſſary on this occaſion, it will be proper to premiſe a few words concerning their ſenſible qualities.

EXTERNAL APPEARANCE.

Three clear glaſs bottles, each of a quart contents, were filled ſeverally with the water of the King's Bath *, the Hot Bath, and the Croſs Bath, then immediately cloſed up and ſet to ſtand. They all, when firſt filled, appeared at firſt ſight colourleſs and pellucid.

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* When the Bath Waters are mentioned in the enſuing Experiments without any addition, they are to be underſtood of them as brought freſh from the pump, in bottles carefully corked, to a ſmall diſtance, where the Experiments were made. When theſe were made with the water which had ſtood ſome time, or at the ſpring head, it is ſo expreſſed.

pellucid. But on a more accurate imſpection, I could perceive many minute white moleculæ floating in each of them, nor could I diſcover, on the cloſeſt examination, which of the ſprings had this appearance in the greateſt degree. They all ſparkled in the bottle, during the filling of it, in the ſame manner that the Spa Water does; and I imagined, that this circumſtance ſeemed to occur more ſtrongly in the water of the King's and Hot Bath, than in that of the Croſs Bath. After ſtanding twenty-four hours they had all acquired ſome ſlight degree of a wheyiſh tinge, ſcarce perceivable unleſs by comparing them with ſome of the water of the ſame Baths freſh drawn, and I thought that this ſeemed rather more perceivable in the bottle filled with the water of the King's Bath, than either of the other two. They all had depoſited a very ſlight ochrous ſediment, only juſt perceivable in the water of the Hot and Croſs Baths, but more diſcoverable in that of the King's Bath; though even in this the quantity precipitated was extremely ſmall. This ſediment is collected round the edges of all the Baths, but moſt remarkably in the King's Bath.

On ſuffering them to ſtand twenty-four hours longer unſtopped, the wheyiſh tinge became more conſpicuous, but no precipitation was depoſited, except the ſlight ochrous one before-mentioned.

ODOUR.

None of the waters have any particular ſmell that I could diſcover, either in the waters themſelves, or in the vapour ariſing from them. Some little degree of pungency, without any diſtinguiſhing peculiarity, I have ſometimes perceived, reſembling that ariſing from efferveſcent mixtures, or fermenting liquors. I have perceived this, in ſome degree, in each of the Baths, but I think it is more diſcernible in the Hot Bath and King's Bath, than in the Croſs Bath.

TASTE.

Theſe waters are all ſlightly ſaline, accompanied with an agreeable pungency, added to a light chalybeate taſte. To me the King's Bath ſeems to poſſeſs the two laſt of theſe qualities in the greateſt degree, though I have met with ſeveral, who thought them more prevalent in the Hot

PART III. Bath water. Beyond all doubt, however, the chalybeate impregnation is moſt perceivable in the King's Bath Water; and I believe moſt people think, that the water of the Croſs Bath poſſeſſes the leaſt pungency. On cooling, the chalybeate taſte and the pungency go off entirely, (though I think the Hot Bath retains both of theſe qualities the longeſt,) when the water becomes much leſs agreeable, the ſaline taſte becomes more manifeſt, and ſeems accompanied with another, different from the taſte of any ſaline body I am acquainted with, though on long ſtanding this peculiarity of flavour goes off alſo. This particularity of taſte appears to me moſt remarkable in the King's Bath, though others think it more perceivable in the Hot Bath.

TEMPERATURE.

The heat of each of theſe waters is variouſly laid down. According to the beſt experiments I could make, the heat of the King's Bath Water, and that of the other Baths, as commonly drank, is as follows:

King's Bath	116
Hot Bath	116
Croſs Bath	112

I once found the thermometer raiſed by the King's Bath, after pumping, to 118 degrees; but I imagine that this rarely happens, ſo that I ſuppoſe the general heat at which they are taken ſcarce exceeds 116 degrees.

CONTENTS *of the* BATH WATERS *on Evaporation.*

Six gallons of the King's Bath Water were evaporated to about a quart. Before this, a conſiderable quantity of a whitiſh powdery ſubſtance, in part cryſtallized, was depoſited round the edges of the veſſel adjoining to the fluid, and ſeveral pellicles were formed, which ſucceſſively precipitated in a laminated form. The remainder of the liquor had a taſte evidently ſaline, but not ſo ſtrongly as might have been expected, as it was proved to be at leaſt a ſaturated ſolution from the cryſtallization of the ſaline matter. On evaporation to dryneſs, with a very gentle heat, there remained ſeven drachms and half a ſcruple of a ſubſtance of a duſky browniſh colour, with a yellowiſh tinge, adhering ſtrongly to the bottom of the veſſel. The ſame circumſtances happened in the evaporation of the water of the Hot and Croſs Baths as of the King's Bath, ſave that the reſiduum of ſix gallons of the Hot Bath Water weighed ſeven drachms, two ſcruples, and eleven grains; and that of the Croſs Bath, one ounce, one ſcruple, and fifteen grains. The reſidua of the Hot and Croſs Baths were of a light brown, and not by ſeveral ſhades ſo dark as the reſiduum of the King's Bath; and I think that, of the two, the colour of the reſiduum of the Hot Bath was moſt inclining to a white.

EXAMINATION *of the ſeveral* RESIDUA.

None of the reſidua had the leaſt perceptible odour, but to the taſte were all evidently ſaline; which of them were moſt ſo, I was not able to diſcern with any certainty; but that of the Croſs Bath was evidently leſs ſo than either of the others. On examination of the ſeveral reſidua with the microſcope, the greateſt part of them appeared in a powdery form, reſembling an earthy ſubſtance, and the mainder made up of cubical and ſmall hexagonal priſmatic cryſtals, ſome of them terminating in a pyramid, and others truncated.

CHEMICAL ANALYSIS *of the* RESIDUUM.

EXPERIMENT I.

Four ſcruples of the reſiduum of the King's Bath Water were waſhed in repeated portions of warm diſtilled water, until the reſiduum had loſt all its ſaline taſte. Each of theſe portions, in all about two thirds of a pint, were put together in a china baſon, and evaporated ſlowly over a lamp. When the water was nearly diſſipated, it was taken from the fire, and ſet to ſtand in a warm place until the remainder of the moiſture was evaporated; there then remained one ſcruple and eleven grains of a white ſubſtance, entirely cryſtalized, and of a ſaline taſte, reſembling common ſalt, and wholly ſoluble in water, and which, when examined by the microſcope, appeared to be entirely compoſed of cubical cryſtals.

PART III.

EXPERIMENT II.

The above Experiment was repeated with the reſiduum of the Hot and Croſs Bath Waters, but no perceivable difference was obſerved, except in the quantity of

PART III. ſaline ſubſtance gained, which was one ſcruple and nine grains from four ſcruples of the Hot Bath reſiduum, and eleven grains only from a like quantity of that of the Croſs Bath. The taſte and appearance of the ſaline ſubſtance gained was apparently the ſame in all.

EXPERIMENT III.

Vitriolic acid to the ſaline ſubſtance gained from the reſiduum.

To ten grains of each of theſe ſalts were added three drops of the vitriolic acid: Immediately the ſmell of the ſpirit of ſalt became perceivable.

EXPERIMENT IV.

Solution of ſilver.

To three ounces of diſtilled water was added two drops of ſolution of ſilver in the nitrous acid, which produced no change of colour. To this was added one grain of the cubical ſalt gained as above from the reſiduum of the King's Bath Water, when it all aſſumed a milky appearance.

EXPERIMENT V.

The ſame was tried with the ſaline ſubſtance gained from the reſiduum of the Hot and Croſs Bath Waters with exactly the ſame event.

Ex-

EXPERIMENT VI.

PART III.

Vegetable blues.

To two drachms of diſtilled water was added ſix grains of the ſaline ſubſtance procured in Experiment I. from the reſiduum of the King's Bath Water. Into this ſolution was put a ſlip of paper rubbed over with the flowers of freſh violets; no perceptible change of colour could be diſcovered.

EXPERIMENT VII.

The ſame Experiment was tried with the ſaline ſubſtance extracted from the reſiduum of the Hot and Croſs Bath Waters, with the ſame event.

EXPERIMENT VIII.

Spirit of nitre to the groſs reſiduum.

To one drachm of the groſs reſiduum of the King's Bath Water was added three ounces of diſtilled water. To this I added twenty drops of ſpirit of nitre; a conſiderable effervefcence enſued, and * a part of the reſiduum was diſſolved, which was not

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* The nitrous acid was uſed here preferable to the vitriolic, becauſe the reſiduum which remained undiſſolved was probably Selenites, which is not affected by the nitrous acid; but on addition of a ſuperabundant quantity of vitriolic acid diſſolves eaſily in water, although ſo difficult of ſolution

PART III. affected by water alone. But nearly one third part remained, which could not be rendered ſoluble by theſe means, although I added forty drops of the nitrous acid.

EXPERIMENT IX.

To one drachm of the groſs reſiduum of the Hot Bath Water was added twenty drops of ſpirit of nitre, as in the foregoing Experiment. An effervеſcence enſued, but not ſo great as in the laſt Experiment, and a part of the reſiduum was diſſolved on addition of the acid, but ſtill could not be rendered entirely ſoluble, even by addition of forty drops more; nearly the ſame proportion remaining inſoluble as in the reſiduum of the King's Bath Water.

EXPERIMENT X.

The above Experiment was tried with the reſiduum of the Croſs Bath Water. In this caſe the effervеſcence was remarkably

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in the ſtate we generally ſee it. This may, perhaps, account for its being contained more largely in ſome ſprings than its ſolubility in water would account for by any other means; and is, in my opinion, a preſumptive evidence, that the vitriolic acid is preſent in its ſeparate ſtate in ſome Mineral Waters.

ably leſs than in the other two inſtances, and a much larger portion of the reſiduum remained inſoluble.

EXPERIMENT XI.

Thirty grains of each of the reſidua of the ſeveral Baths were laid on a red hot poker; a ſlight decrepitation enſued in each, but no flame or detonation was obſerved in any, although I added to each a few grains of charcoal, nor was any perceptible odour emitted. The colour of each of the reſidua was only rendered rather darker.

EXPERIMENT XII.

Lixivium tartari to the groſs reſiduum.

Two drachms of each of the reſidua were ſeverally added to ſix ounces of water, and ſtirred up, and then ſuffered to ſtand about an hour. To each of theſe was added twenty drops of lixivium tartari, a cloudy appearance, of a milky colour, was formed in contact with the reſiduum in all of them, but very little appeared in any through the body of the liquor.

N. B. I repeated this Experiment, and filtred the liquors, after having let them ſtand ſome time on the reſidua. Lixivium tartari then made ſcarce any precipitation in any of them.

EXPERIMENT XIII.

Having obſerved a yellow ochery ſubſtance that concretes round the edges and ſides of all the Baths, but moſt remarkably in the King's Bath, I procured ſome from the latter, and made it up into a paſte with a little oil, and put it into a crucible placed in a hot fire, and on keeping it there a few minutes, poured it out, and, when cool, found ſeveral of its particles ſtrongly attracted by the magnet.

N. B. I repeated this Experiment with ſome of the ſame kind of ſubſtance, procured from the Hot and Croſs Baths, with the ſame event.

ANALYSIS *of the* WATERS.

EXPERIMENT XIV.

Lixivium ſapon. to the Bath Waters.

To eight ounces of the Water of the King's Hot and Croſs Baths, were added twenty drops of ſoap ley. This cauſed a very conſiderable milkineſs through the body of the fluid, in each of them.

EXPERIMENT XV.

PART III.

To eight ounces of the Water of the ſeveral Baths, that had ſtood corked about half an hour, was added a like quantity of ſoap ley. A ſlight milky colour was produced in all of them, which was moſt perceivable in the Waters of the Hot and King's Baths, but leſs than in the preceding Experiments, and when tried after the Waters having ſtood twenty-four hours was ſcarce perceptible.

EXPERIMENT XVI.

Lixivium tartari.

To eight ounces of the Water of the ſeveral Baths was added twenty drops of lixivium tartari. This cauſed in all a copious and ſudden precipitation of a flaky appearance, much more conſiderable than in Experiment XIV. They all ſhewed a reddiſh tinge in the precipitation, but that was moſt obſervable in the King's and Hot Bath Water.

EXPERIMENT XVII.

Sp. ſal ammon. cum calce vivâ.

To eight ounces of the ſeveral waters was added ſixty drops of ſpirit of ſal ammoniac, with quick-lime. A ſlight milky cloudineſs appeared in each, though ſcarce perceptible.

EXPERIMENT XVIII.

Sp. ſal. ammon. commun.

To eight ounces of the ſeveral waters were added ſixty drops of common ſpirit of ſal ammoniac. This cauſed a degree of cloud and precipitation, conſiderably greater than in Experiment XVII. but not ſo great as when lixiv. tart. was uſed.

EXPERIMENT XIX.

Lime-water.

To eight ounces of the water of the King's hot and Croſs Baths, freſh pumped, was added two ounces of lime water; a ſudden flaky precipitation, of a blueiſh white tinge, happened in all, but was moſt copious in the water of the King's, and leaſt ſo in that of the Croſs Bath; the precipitated matter in all of them remained at the bottom, in form of ſnow, and not in a white powder, as in the Experiment with lixivium tartari. I repeated this Experiment with the ſame waters, which had ſtood looſely corked about half an hour, when the precipitation was much leſs than in the foregoing inſtance, but ſtill greateſt in the King's Bath water, and next to that, in the Hot Bath water, and leaſt of all, in that of the Croſs Bath.

EXPERIMENT XX.

To eight ounces of the King's Hot and Croſs Bath waters, that had ſtood in bottles uncorked twenty-four hours, I added to each two ounces of lime-water; no change of appearance or precipitation took place.

N. B. No effervеſcence was obſerved, on addition of any of the above-mentioned ſubſtances to the Bath Waters. Probably what gave riſe to the common opinion of their effervеſcing with alkalies was, that this Experiment was tried with thoſe ſalts in their ſolid form, and the air bubbles formed in the ſolution, were miſtaken for an effervеſcence.

EXPERIMENT XXI.

To each of the waters of the Baths, precipitated as in Experiments XIV. XV. XVI. XVII. XVIII. and XIX. was added five drops of ſpirit of nitre, which reſtored them all to their tranſparency.

EXPERIMENT XXII.

Vitriolic acid.

To eight ounces of the King's Hot and Croſs Bath waters, were added twenty drops of ſpirit of vitriol, without the leaſt precipitation, or ſenſible change in any of them.

Nitrous, muriatic, and vegetable.

N. B. This Experiment was repeated with the nitrous, muriatic, and vegetable acids, without producing any alteration in the water of any of the ſprings.

EXPERIMENT XXIII.

Solution of ſilver.

To four ounces of the King's Hot and Croſs Bath waters, was added ſix drops of ſolution of ſilver in the nitrous acid. A conſiderable cloudy precipitation, with ſome degree of a pink tinge, immediately took place in each, but the change of colour was rather more remarkable in the water of the Hot and Croſs Baths, than in that of the King's Bath.

EXPERIMENT XXIV.

Solution of lead.

To four ounces of the waters of the King's Hot and Croſs Baths, were added ſix drops of ſolution of lead in the nitrous acid. A white cloudineſs immediately took place, with a faint pink tinge, which laſt was likewiſe rather more remarkable in the water of the Hot and Croſs Baths, than in the King's.

EXPERIMENT XXV.

Solution of mercury.

To four ounces of each of the waters was added ſix drops of the ſolution of mercury in the nitrous acid. A cloudineſs immediately took place in each, of a light yellowiſh colour, but I could not diſcover in which it was moſt obſervable.

EXPERIMENT XXVI.

Solution of copper.

To four ounces of the waters of the ſeveral ſprings, I added ten drops of ſolution of copper in the nitrous acid; this gave a light blue tinge to each of them, with a ſlight flaky precipitation.

N. B. The colour imparted to any of the waters in this Experiment, was not deeper than when the ſame quantity of the ſolution was added to four ounces of diſtilled water.

EXPERIMENT XXVII.

Solution of ſugar of lead.

To eight ounces of the waters of the above-mentioned ſprings, were ſeverally

added

PART III. added a tea-ſpoonful of ſolution of ſacch. ſaturni in water; a whitiſh cloudy precipitation appeared in each, but was rather more copious in the Croſs Bath water.

EXPERIMENT XXVIII.

Solution of corroſive ſublimate.

To eight ounces of the water of the ſeveral Baths, were added to each twenty drops of a ſolution of corroſive ſublimate in water. No change occurred in any for ſome time, but on ſtanding, I could perceive a faint blueiſh white cloud, and a ſlight film on the ſurface of the waters of the King's and Hot Bath, and a ſlight degree of cloud in the water of the Croſs Bath; a ſmall yellowiſh precipitation took place in the Hot Bath and King's Bath, which was not obſerved in the Croſs Bath Water.

EXPERIMENT XXIX.

Tincture of galls.

To eight ounces of the ſeveral waters, I added thirty drops of tincture of galls, made with brandy. This occaſioned in all of them a ſlight purple tinge, which was rather deeper in the water of the King's Bath than in the Hot and Croſs Bath Waters, which ſeemed nearly of a ſimilar tinge.

EXPERIMENT XXX.

PART III.

To a quart of diſtilled water I added one drop of ſolution of green vitriol in water; I then put in twenty drops of tincture of galls, drop by drop; the purple colour produced was very faint at firſt, but on ſtanding, increaſed; and on adding a tea-ſpoonful of lime-water, grew much deeper than in the laſt Experiment.

N. B. The purple tinge cauſed by adding tincture of galls to the Bath Waters, was not increaſed in the leaſt by the addition of lime-water.

EXPERIMENT XXXI.

Vegetable blues.

Several ſlips of paper rubbed with the flowers of freſh violets were immerſed in the waters of the ſeveral Baths; the purple tinge ſeemed rather heightened by the water freſh drawn, but after ſtanding, it ſeemed to change them rather to a greeniſh caſt.

N.B. The King's Bath Water appeared to heighten the colour more than either of the others.

Experiment XXXII.

Soap.

Two ounces of the waters of the ſeveral Baths were each of them agitated with half a drachm of caſtile ſoap; the ſeveral fluids appeared flaky and turbid, and on ſtanding, a curdled oily ſubſtance floated on the top, and the water beneath became again clear.

N.B. The King's Bath Water ſeemed to make the moſt entire ſeparation of the oily parts.

Experiment XXXIII.

Milk.

To two ounces of milk, boiling hot, was added four ounces of the King's Bath Water; a light curd was ſoon formed, but not an entire ſeparation of the cheeſy parts, as the whey retained ſome degree of a milky appearance.

N. B. This Experiment was tried with the waters of the Hot and Croſs Baths, and in both of theſe ſome precipitation of a curdled ſubſtance was obſerved to take place; but the ſeparation was not ſo compleat as when the King's Bath Water was uſed. The coagulation of the milk did not take place when mixed with any of the Waters that had ſtood open ſome time, or been ſuffered to cool.

Part III.

Experiment XXXIV.

A pitcher with a narrow neck, of a gallon and a half contents, was filled with the King's Bath Water from the pump, and a ſyphon immediately inſerted into the neck of it, communicating with a bottle containing eight ounces of lime water. No turbidneſs appeared for ſome time, but a thin film was, after two hours ſtanding, formed on the ſurface of the lime-water, and on longer ſtanding a ſlight cloudineſs was perceivable in the upper part near the ſurface, though the communication with the outward air was entirely prevented.

N. B. This Experiment did not ſucceed except made with the water freſh drawn. I tried the above Experiment with the Hot and Croſs Bath Waters, with ſomething of the ſame effect, though in a leſs degree.

Experiment XXXV.

Inſtead of the vapour ariſing from the Bath Water, I conveyed that which aroſe from mixing lixivium tartari with the nitrous acid into a bottle containing a like quantity of lime-water; this cauſed an immediate cloudineſs in the lime-water, and film on the ſurface, and in a ſhort time a precipitation of all the lime in a flaky form.

EXPERIMENT XXXVI.

A drachm of ſteel filings was put into a bottle, and to it added ſix ounces of the King's Bath Water, and the whole ſhaken up. After ſtanding a quarter of an hour, the water was poured off and filtred. On addition of twenty drops of tincture of galls, it ſtruck a purple colour many ſhades deeper than when the trial was made with the ſimple Bath Water.

I tried the Experiment with the waters of the other two Baths with the ſame event, though in a leſs degree, and I found likewiſe that it ſucceeded in ſome degree with all the waters, even when grown cold.

EXPERIMENT XXXVII.

A piece of lean mutton, which was grown tender by keeping, was divided into four parts, each weighing one drachm, and

PART III.

each of theſe were put into four ounces of the waters of the Hot, King's, and Croſs Baths, filled from the pump, and immediately cloſed up, and the fourth into an equal quantity of diſtilled water, heated to a like degree, which was immediately cloſed likewiſe. After ſtanding twelve hours, I took out the corks, and placed them in a room of the temperature of fifty-eight or ſixty degrees of heat. In three days, that in the diſtilled water had acquired a degree of fœtor, and emitted ſome bubbles, but the other three were perfectly ſweet. On the fourth, that in the diſtilled water was very fœtid, and that in the Croſs Bath Water began to ſmell, and emit bubbles from it. On the fifth day, the piece of fleſh in the diſtilled water was grown extremely fœtid, and was become ſo tender as to be ſeparated into ſmall bits by a ſlight force. That in the Croſs Bath Water had emitted many air-bubbles, and had an evident putrid fœtor, yet the coheſion of its parts was not remarkably leſs then than when freſh. The pieces in the Hot and King's Bath Waters had ſome air-bubbles adhering to them, and had ſome, though a very ſmall degree of fœtor. I then removed them

PART III. them all into ſeparate bottles, and waſhed three of them with the waters in which they had been at firſt immerſed, by placing them under the pumps, and waſhed the fourth with diſtilled water of a like heat. The fœtor in thoſe pieces which had been immerſed in the Hot and King's Bath Waters was ſoon removed, but no great alteration was perceived in that of the Croſs Bath, ſave a ſmall abatement of the fœtor, owing to ſome of the moſt putrid particles being waſhed off; that in the diſtilled water loſt all its coheſion on addition of the hot water, and fell to-pieces. The coheſion of thoſe pieces which were immerſed in the Hot and King's Bath Water was not remarkably altered.

EXPERIMENT XXXVIII.

I took a piece of lean mutton, weighing one ounce, which had acquired a ſlight degree of fœtor, and divided it into three pieces of equal weight, put each into an open bottle, and placed one under the King's, another under the Hot, and a third under the Croſs Bath pumps. After pumping on them about three minutes, they were removed, and the fœtor in thoſe that were placed under the Hot and King's Bath was entirely gone off, and that under the Croſs Bath nearly ſo likewiſe. I tried the above Experiment with hot water, but the fœtor, though abated, was not entirely removed.

SOCIETY

EXPERIMENT XXXIX.

I took three pieces of lean mutton, that had acquired a conſiderable putrid fœtor, and placed them under the pumps, as in the foregoing Experiment, but the putrid ſmell could not be thereby corrected in quality, though leſs in degree, which laſt was probably owing only to the waſhing off ſome of the moſt putrid particles.

EXAMINATION *of the* SAND *found in the Ciſtern of the* KING'S BATH.

Near the middle of the King's Bath, about four feet below the ſurface, is a large leaden reſervoir, through which ſome of the principal ſprings flow, in their paſſage upwards into the Bath, and into which the pipe which ſupplies the pump is inſerted. Once in three or four years (as I am informed) this is opened, in order to clear it of a ſandy ſubſtance, which the water brings up and depoſits there, and which, if ſuffered to accumulate, choaks up the end of the pipe which ſupplies the pump.

This ſand is moderately fine, of a light grey colour, intermixed with a number of black particles, which, when examined through a microſcope, appeared not to be cryſtalline ſubſtances, like great part of the remainder of the ſand.

It is not more ponderous than common ſand of the ſame fineneſs.

The Hot and Croſs Baths have a reſervoir of nearly the ſame conſtruction, but I cannot find that it is ever neceſſary to open them on the ſame account, or that any ſubſtance of this kind was ever found in them.

Chemical ANALYSIS *of the* SAND *found in the Ciſtern of the* KING'S BATH.

EXPERIMENT XL.

A drachm of the vitriolic acid diluted with four times its quantity of water was added to half an ounce of the King's Bath ſand; a ſharp effervesſcence enſued, and many air bubbles were formed.

The like happened on addition of the nitrous, muriatic, and vegetable acids; with the laſt, however, in a very ſmall degree.

EXPERIMENT XLI.

This ſand ſprinkled on a red hot iron gives a blue flame, and emits a highly acid vapour, in ſmell like that diſcharged from burning ſulphur.

EXPERIMENT XLII.

About two drachms of the Bath ſand were put into a crucible, with an equal weight of powdered charcoal. When the matter was thoroughly heated red hot, it was poured out, ſeveral particles of it were then vigorouſly attracted by the magnet.

To the taſte the Bath ſand is not in the leaſt ſaline, but impreſſes, on being kept in the mouth ſome time, a ſtrong chalybeate taſte.

PART III.

EXPERIMENT XLIII.

Two ounces of diſtilled water were infuſed on two drachms of Bath ſand in a vial, which was kept in a moderate heat about an hour; the taſte of the liquor was then highly chalybeate, but not obviouſly ſulphureous. On addition of twelve drops of tincture of galls, little change was produced, except a ſlight purple tinge. By dropping in, however, four drops of lixivium tartari, the whole turned to a deep purple, nearly approaching to black.

This Experiment ſucceeded equally well when the Bath Water was uſed either freſh from the ſpring, or when grown cold.

EXPERIMENTS *on the* STONE *found near the City of* BATH.

Among the hills ſurrounding this city are found divers quarries of ſtone, of different ſorts, which are principally uſed in building. As this is found in vaſt quantities round the city, it was thought proper to examine ſome of the kinds, as it was very probable that the hot ſprings in their courſe might flow through ſeveral beds of this ſubſtance.

It is of ſeveral kinds, varying conſiderably in point of hardneſs, but the two moſt remarkable are that which is uſed for building the rough walls, and that which is uſed for caſing buildings and making ornaments. They are both very ſoft as ſtones, but the former is much the harder of the two, though ſtill ſoft enough to be worked with a ſtone axe. It is of a light brown colour, with a tinge more inclining to yellow. They both effervеſce and diſſolve in acids. The harder ſtone contains about one fifth part ſoluble in ſpirit of nitre, and the ſofter about one third. They harden on expoſure to the air, and when got at a proper ſeaſon, viz. the beginning of ſummer, in general ſtand the weather well, but when dug in the autumn, or winter months, are apt to crack by the froſt, from their containing a great quantity of moiſture when freſh dug, which is frozen in the ſtone before it can exhale.

EXPERIMENT XLIV.

I powdered about an ounce of the ſofteſt kind of Bath ſtone, and infuſed it in a pint of diſtilled water, and then filtred it. It

PART III. contained a degree of wheyiſh tinge, from which I could not free it even by repeated filtrations. The filtred liquor had a taſte evidently reſembling lime-water, in that rough ſenſation with which it affects the roof of the mouth, though deſtitute of its empyreumatic flavour.

EXPERIMENT XLV.

An ounce of the ſame ſtone uſed in the foregoing Experiment, was powdered, and well rubbed in a mortar, with a drachm of flowers of ſulphur. To this was gradually added, during the trituration, a pint of diſtilled water heated to one hundred and twenty degrees, or a little more, and then filtred. The filtred liquor was perfectly clear, but had a taſte evidently ſulphureous; and when warmed again to the ſame degree of heat, was judged, by ſeveral who taſted it, to reſemble the Bath Waters very much, eſpecially that of the Hot Bath.

I repeated this Experiment with the harder kind of ſtone, uſed for building rough walls, and found the ſame effect, though in a leſs degree.

EXPERIMENT XLVI.

PART III.

I took an ounce of the ſoft ſtone powdered, and triturated it in a mortar, with half an ounce of the King's Bath ſand, and gradually added, during the trituration, a pint of diſtilled water, heated to one hundred and twenty degrees, and then filtred it. The taſte was evidently ſulphureous, and when heated to the ſame degree, reſembling the Bath Waters very much.

APPLICATION *of the foregoing* EXPERIMENTS.

I ſhall now endeavour to apply theſe Experiments to the diſcovery of the impregnation of the Waters.

And here I ſhall take another view of the ſubſtances before mentioned, as poſſible impregnations of Mineral Waters, in the order they are there placed, and endeavour to ſhew of each what proof or probability there may be that it has or has not a ſhare in the compoſition of the Bath Waters. The firſt of theſe that occurs is,

ACIDS.

* I. *The* VITRIOLIC ACID.

PART III. The exiſtence of this ſubſtance in its ſeparate ſtate in the waters has been much diſputed. Even their ſenſible qualities, with reſpect to this impregnation, have not been clearly aſcertained.

I cannot ſay I have ever had an opportunity of obſerving its effects in ſo ſenſible a degree as mentioned by Dr. Lucas †, yet am inclined to pay ſome credit to it, as this acid is probably preſent in the waters united with iron, which it quits as ſoon as it communicates with the open air. This is rendered likely by Experiment XXIX. with tincture of galls, by the ochrous incruſtations depoſited round the ſurface and ſides of the Baths, which were ſhewn to be reducible into iron, and by the ſand itſelf of the King's Bath imparting a chalybeate quality to common water. Arguments, however, ſufficiently plauſible, are not wanting to contradict the exiſtence of an unneutralized acid in theſe waters, even though it was granted that their vapour were ſo.

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* Theſe marks, in this ſeries, refer to the Table of Impregnations, p. 194.

† Vol. III. p. 227.

The Vitriolic Acid in theſe caſes, it may be alledged, flies off, as it is diſunited from the iron, and does not remain in the water in its ſeparate ſtate. The ſenſible qualities of the waters ſeem to favour this opinion. No acidity has been ever aſſerted by any perſon, whoſe writings I have examined, to be perceptible to the taſte, and the trite experiment of ſyrup of violets being turned green by it, has been brought as a proof of a very different impregnation, and ſuch a one as could not poſſibly ſubſiſt with the other. It has, however, been urged, that the Bath Water curdles milk, decompoſes ſoap, and efferveſces with alkaline ſalts, which are all properties belonging to acid bodies. That waters containing an acid would produce theſe effects is certainly true, but the two former of theſe are not qualities peculiar to acids only, but producible by means of other ſubſtances, and the laſt I cannot help believing a miſtake. By Experiment XVI. it did not appear that any efferveſcence was produced on

ſuch

PART III. ſuch admixture, although the lixivium tartari which was uſed is the mildeſt ſtate of alkaline ſalts we know of, and of conſequence moſt favourable to a diſcovery of this kind. Probably this miſtake was produced by the cauſe mentioned in the foregoing Experiments.

The principal reaſons that induce me to ſuſpect that the Vitriolic Acid is preſent here, are, that the Bath Water heightens the colour of the vegetable purples, and gives a yellow precipitation with ſolution of mercury*. On the whole, then, if this acid be preſent here, which is very doubtful, it is in exceeding ſmall quantity, and which probably, conſidered as ſuch, can have very little power in influencing its effects as a mineral water, as it is likely that a quantity of it, not exceeding a drop of the concentrated Vitriolic Acid, is preſent in many pounds of the water. This is rendered farther probable, by the Experiment before cited of it, when combined with iron. This proportion being ſo ſmall, perhaps may be the reaſon why they exhibit none, or no perceptible effervesſcence, with alkaline bodies. The King's Bath ſeems to give more marks of containing this ſubſtance than either of the other two.

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* Vide Experiment XXV.

PART III.

ALKALIES.

II. *The* FOSSIL ALKALI.

Was the above opinion with reſpect to the laſt mentioned ſubſtance aſcertained, we might be well aſſured that this had no ſhare in the impregnation of the waters in its ſeparate ſtate; but as that is offered only as matter of conjecture, I ſhall examine the reaſons which might ſupport or contradict the opinion of the preſence of this ſubſtance in theſe waters.

The only circumſtance that gives us any reaſon to think that the Foſſil Alkali enters into their compoſition, is, that the vegetable blues and purples ſeem to acquire a greeniſh caſt, on being added to the water, which has ſtood ſome time. This, however, though a quality of alkalies, is by no means a certain teſt of that ſubſtance. Waters impregnated with calcareous earths, in form of quick lime, will produce this effect as well as alkalies, though not in-

deed

deed ſo powerfully. No marks of this ſalt appeared in the reſiduum left on evaporation of any of them, and the precipitation of ſilver, lead, and mercury, from their ſolutions, was probably owing to another cauſe, which I ſhall mention hereafter. The iron contained in the water in a ſtate of ſolution by an acid, the curdling of ſoap, and the coagulation of milk, likewiſe afford ſufficient proof that this ſubſtance, in its native form, uncombined with any other body, has no ſhare in the compoſition of theſe celebrated waters.

III. VOLATILE ALKALI.

The Experiment XXVI. with ſolution of copper, is an evident proof that the Volatile Alkali does not enter into the compoſition of the Bath Waters.

COMPOUND SALTS.

IV. GLAUBER'S SALT.

It does not appear by any Experiments, that there is any reaſon to think that this ſalt is contained in the Bath Waters. Some of the cryſtals left on evaporation were, indeed, of an hexagonal priſmatic form, but were likewiſe of a ſlightly auſtere and aſtringent taſte, and of very difficult ſolution in water, qualities that ill agree with Glauber's Salt. Theſe circumſtances afford ſufficient evidence of what has been before laid down, as, if this ſalt had exiſted in the ſmalleſt quantity in the waters in a ſtate of ſolution, it muſt have been thus diſcovered, as this ſalt is not ſo ſubject to decompoſition, by long boiling, as many others are.

V. VITRIOLIC AMMONIAC.

There is not the leaſt reaſon for believing the exiſtence of this ſubſtance in the Bath Waters, ſince it would have, undoubtedly, manifeſted itſelf on addition of ſolution of copper, by the blue colour produced, which is always the caſe when the ſolution of that metal is added to waters, containing any ſaline ſubſtance that has the volatile alkali in its compoſition.

VI. COMMON SALT.

The exiſtence of this ſubſtance in the Bath Waters has been pretty generally acknowledged, though its proportion there ſeems too ſmall to have any ſhare in their medicinal effects. The cubical figure and peculiar taſte of the cryſtals are a ſufficient evidence of this, as no other ſaline ſubſtance, that we are acquainted with, takes that form on cryſtallization. To this likewiſe is owing the precipitation of lead and ſilver * from their ſolutions.

Theſe, joined to the Experiments III, IV, and V. render the preſence of this ſubſtance very certain, though it is but in a very ſmall proportion, and probably but of little conſequence in producing any of the effects uſually attributed to the Bath Waters.

For the proportions contained in the ſeveral baths, *Vide* Experiments I. and II. Part III.

VII. SAL AMMONIAC.

This is proved not to be preſent in the Bath Waters, for the reaſon before given of Vitriolic Ammoniac.

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* The Vitriolic Acid, and the ſalts containing it, precipitate the ſolutions of lead and ſilver. But the precipitation is not near ſo plentiful as when occaſioned by common ſalt, and always aſſumes more or leſs of a yellow tinge, whereas this was of a milky whiteneſs.

INFLAMMABLE BODIES.

VIII. FOSSILE OIL, *per ſe*.

The next claſs of bodies that offers itſelf to our view is that of Inflammables, among which the Foſſile Oil, in its ſeparate ſtate, bears the firſt place. Of this, however, I have little more to ſay, than that the Bath Waters do not give the leaſt ſuſpicion of any impregnation of this kind, either by their ſenſible qualities, or chemical analyſis. The taſte and ſmell of this ſubſtance are, indeed, in general, ſo potent, and ſo diſtinguiſhable, as to leave no room for a miſtake of this for any other impregnation. The immiſcibility of this oil with water likewiſe affords an eaſy and obvious method of detecting it, even though its quantity ſhould be too ſmall, and its nature too pure, to admit of a diſcovery, from its other ſenſible qualities *.

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* The Foſſile Oils, when pure, in form of naphtha, are thin, nearly colourleſs, and tranſparent, and have none of that ſtrong ſmell and flavour they ſo eminently poſſeſs in the form we get them. The two laſt qualities are probably owing to the admixture of ſome foreign body, which a great Chemiſt thinks to be the Vitriolic Acid.

PART III.

As this oil, however, is not in the leaſt degree ſoluble, and only diffuſible in water, however minute this may be, it muſt ſeparate on ſtanding.

But no ſuch circumſtance has ever been obſerved in the Bath Waters, nor do their ſmell, taſte, *&c.* favour any opinion of this kind. We may therefore ſafely conclude, that the Bath Waters do not contain this ſubſtance in the ſmalleſt degree.

IX. FOSSIL OIL *in form of* SOAP.

There does not ſeem to be any more reaſon for believing that this ſubſtance is contained in the water in its compound, than in its ſimple ſtate. The taſte and ſmell of it would be equally diſtinguiſhable in this, as in the laſt mentioned form. And if even (for the reaſons above-mentioned) theſe might not be ſo obſervable, yet an addition of any acid ſubſtance would preſently make the diſcovery, by the ſeparation of the oil from the water it was united with. If the opinion, that the Bath Water contained Vitriolic Acid in ſubſtance, was confirmed, it would put an end to all doubts of this kind at once, but as I offer that only as matter of ſome probability, I ſhall not lay any ſtreſs on it in point of argument. If the oil were thus combined with the water in form of ſoap, it muſt diminiſh its tranſparency, (ſince the the oil is then only in a ſtate of minute diffuſion through the water.) But as none of theſe circumſtances occur, we may rationally believe, that there are no more grounds for believing that oily ſubſtances are contained in the waters in this, than the laſt mentioned form.

X. SULPHUR *per ſe.*

I now come to the laſt impregnation of this kind, viz. Sulphur. This queſtion has been much agitated by many able Writers, ſome of whom have maintained, and others denied, its exiſtence there, with as much vehemence, as they would have done had every thing valuable belonging to them depended on this ſimple queſtion.

I ſhall briefly examine the arguments that may be brought in favour of, or againſt, the opinion of the exiſtence of this ſubſtance in the Bath Waters.

In confirmation of its exiſtence, it has been ſaid, that the ſand and mud taken up from

PART III. from the bottoms of the Baths, are evidently ſulphureous from their ſmell; that the former, laid on a red hot iron, emits a blue flame and a ſuffocating vapour; that a ſolution of mercury is precipitated in yellow clouds by it, which is the colour it aſſumes when precipitated by ſulphureous bodies; that corroſive ſublimate is decompoſed in the ſame manner; that a ſolution of ſilver in the nitrous acid is precipitated by them; that the mud of the waters, ſublimed with arſenic in a retort, produced a true orpiment, and that the reſiduum left by the waters had the ſame effect.

On the other hand it has been alledged, that, granting the ſand and mud taken from the bottom of the Baths contained ſulphur in any proportion, yet that would not prove its exiſtence in the waters, ſince we know ſulphur to be inſoluble in a watery menſtruum, and that if it were united with the water by means of a ſubtile diffuſion, that this would be ſoon diſcovered, by the precipitations happening on the waters ſtanding, by the incruſtations of the ciſterns into which it firſt ſprings, and of the pipes through which it flows, as at Aix-la-Chapelle,

PART III.

Chapelle, none of which circumſtances are ever obſerved here. That the ſolutions of mercury and corroſive ſublimate were changed to a yellow colour by the vitriolic acid, and that the bluiſh white clouds ſuddenly precipitating in grumes, on addition of the ſolution of ſilver, are owing to the common ſalt contained in the water. That the reſiduum, on evaporation, appears to be moſtly a calcareous earth, and the remainder a ſaline ſubſtance, and that it gives no appearance of ſulphur when laid on a red hot iron, only fuming and crackling ſlightly, without any ſulphureous ſmell*, blue flame, ſparkles, or detonation; that its effervefcence with acids proved it not to be ſulphureous, as that ſubſtance is not affected by them; that the taſte of it ſhewed no ſigns of any contents of this nature, being only ſimply ſaline, and that but in a moderate degree; that the colour of bright poliſhed ſilver was not tarniſhed or impaired by lying in the waters a conſiderable length of time†.

On a review of theſe arguments I am inclined to think, that the latter, on the

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* Lucas, vol. iii. p. 312. † Ib. p. 281.

whole,

PART III. whole, are tolerably concluſive as to this point, though they are far from being all of equal weight, or fairly ſtated. That which has been moſt relied on, viz. of the reſiduum left by the waters on evaporation yielding ſulphur, is the leaſt determinate of any, as the ſulphur, if but in ſmall proportion, would undoubtedly be diſſipated in the evaporation, as ſulphur is decompoſed by long boiling and plentiful dilution with water. Nevertheleſs, as they have no taſte of this kind, nor depoſit any ſubſtance on ſtanding that bears the leaſt reſemblance to it, and do not tarniſh ſilver, or turn black with ſolution of ſacch. ſaturni, we may ſafely conclude, that in this form it makes no part of the compoſition of the water.

XI. HEP. SULPH. *with an* ALKALI.

Sulphur, (as was before obſerved,) though not ſoluble in water *per ſe*, becomes ſo in a conſiderable degree, when combined with a cauſtic alkali, and even in ſome degree with a mild one.

As this combination is by no means infrequent in the bowels of the earth, and is indeed no uncommon impregnation of Mineral Waters, and as thoſe of Bath undoubtedly meet with many ſubſtances in their paſſage that yield ſulphur plentifully (as was taken notice of before,) many have imagined, it was united with them by ſome means of this kind. There ſeems, however, to be little foundation for ſuch a ſuppoſition, as the taſte and ſmell of this compound are ſo diſtinguiſhable, even in ſmall quantities, as to leave little doubt concerning its nature when preſent. No ſuch qualities have been ever obſerved in the Bath Waters. They are nearly inodorous, and their taſte, though peculiar, by no means reſemble thoſe of that kind. Should it be urged, in anſwer, that the quantity contained in the waters is too ſmall to affect their ſenſible qualities, (in which caſe it would be but of little effect,) we may reply, that, even granting it were ſo, chemical experiments by no means favour ſuch an opinion. It appears by theſe, that ſilver is not tarniſhed in the ſmalleſt degree by lying in them, and the ſolution of ſacch. ſaturni precipitated not in a dark coloured, but a yellow cloud. Acids likewiſe make no precipitation in them, which would undoubtedly be the caſe did the ſprings contain ſulphur in this form, as we find by

PART III. experiment of the Harrowage and other waters, that contain an hepar ſulph. of this ſort. We may therefore fairly conclude, that the Bath Waters do not contain ſulphur in this form.

XII. HEPAR SULPH. *with* QUICK-LIME.

Calcareous earths, in their cauſtic ſtate, on being mixed with ſulphur, render it, in ſome degree, ſoluble in a watery menſtruum, as well as alkaline ſalts, though not in ſo large a proportion. From the frequency of both theſe ſubſtances in the earth, we ſhould expect this to be a common impregnation, and indeed I believe it to be much oftener preſent than it is ſuſpected to be.

An eminent Writer on the Bath Waters has taken much pains to prove, that ſulphur makes no part of their compoſition. His reaſonings on this head ſeem well adapted to the ſubject, and prove very fully, that ſulphur, in the two forms above-mentioned, has no ſhare in it. That ingenious Gentleman ſeems to have failed only in making his poſition too general, to which he ſeems to have been induced by too great attachment to theoretical reaſoning, as it does not appear he made any direct experiments to prove this point. It is likely that he concluded, and not without great appearance of probability, that a water thus impregnated would exhibit the ſame appearances with other ſubſtances on experiment, (though perhaps in a leſs degree,) as one that had the true hepar ſulph. in its compoſition.

PART III.

The principal reaſons that induced me to ſuſpect the preſence of ſulphur in this form, were drawn from obſerving, that the Bath ſand contained ſulphur, and a calcareous earth, which have been before obſerved to form a compound ſoluble in water, and that the Bath ſtone joined to ſulphur, and even to the Bath ſand, imparted to water a ſulphureous impregnation. Nevertheleſs, the accounts given of this ſubſtance, and its effects, by ſo eminent a perſon and ſo competent a judge as Dr. Lucas *, by no means correſponding with my Experiments on the Bath Waters, cauſed much doubt with me on this ſubject. However, as the Doctor had related

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* Lucas on Mineral Waters, vol. iii. p. 278.

PART III. no Experiments made with ſulphur in this form, it occurred to me, that he might have overlooked it, for the reaſons above mentioned. This inclined me to make the following comparative Experiments with an artificial preparation of this kind, which turned out totally different from what the Doctor had aſſerted.

EXPERIMENT I.

Two drachms of flowers of ſulphur waſhed, and a like quantity of quick-lime, were rubbed together in a glaſs mortar. To this compound was added, by degrees, during the trituration, ſixteen ounces of diſtilled water. This was afterwards filtred, and appeared a tranſparent fluid *. Its taſte was pretty ſtrong and peculiar, though little reſembling any of the common ſulphureous preparations that I have ſeen, or the Harrowgate Waters.

On ſtanding expoſed to the air, it abated of its pellucidity, and depoſited a whitiſh ſediment,

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* A tea ſpoonful of the above mixture diluted with two ounces of diſtilled water, with the addition of a few grains of common ſalt, formed a compound reſembling the taſte of the King's Bath Water, when grown cold.

ſediment, and this happened, in ſome degree, even when the air was excluded. The quantity taken up by the water ſeemed to diminiſh very little the bulk of the original compound.

PART III.

EXPERIMENT II.

ALKALIES *cauſtic.*

To one ounce of the laſt mentioned preparation, joined to one ounce of diſtilled water, was added ten drops of lixivium ſaponar. This, on ſtanding, produced a ſlight milky colour, with ſome ſmall precipitation, as in the correſponding Experiment with the Bath Waters *.

EXPERIMENT III.

ALCAL. *mild.*

To one ounce of the aforeſaid mixture, diluted as in the laſt Experiment, was added ten drops of lixivium tart. A ſudden flaky and copious precipitation took place, preciſely of the ſame colour as in the cor-

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* On this addition, the diluted mixture became nearly of the taſte of the Harrowgate Spa. N. B. The mixture had the ſame effect on ſoap and its ſolution in rectified ſpirits as the Bath Waters.

PART III. reſpondent Experiment with the Bath Waters, and which, on ſtanding, fell to the bottom, and left the fluid above clear.

EXPERIMENT IV.

ALK. VOLAT. *cauſtic.*

To two ounces of the above mixture, diluted as before, was added forty drops of ſpirit ſal. ammon. c. calce viva, which produced the ſmalleſt degree of a milky caſt, and gave no precipitation on ſtanding.

EXPERIMENT V.

ALK. VOLAT. *mild.*

To two ounces of the above mixture was added forty drops of ſpirit ſal. ammon. commun. This cauſed a milky appearance, with a flaky precipitation, but not ſo conſiderable as in the Experiment with lixivium tartari.

EXPERIMENT VI.

CALCAREOUS EARTHS *deprived of their fixed* AIR.—LIME WATER.

To two ounces of the mixture diluted as aforeſaid, was added half an ounce of lime-water, which produced not the leaſt ſenſible alteration in the body of the fluid.

EXPERIMENT VII.

SOLUTION of METALS *.—Of SILVER in the NITROUS ACID.

PART III.

To two ounces of the mixture diluted as above, was added ſix drops of ſolution of ſilver. This cauſed only a very ſlight milkineſs on ſtanding, ſcarce perceptible.

EXPERIMENT VIII.

Of LEAD in the ſame.

To two ounces of the mixture was added ſix drops of ſolution of lead. This cauſed ſcarce any change, except a very ſlight milkineſs, even leſs than in the former Experiment.

EXPERIMENT IX.

SOLUTION of SACCH. SAT. in WATER.

To two ounces of the mixture as before was added ten drops of the ſolution of ſacch. ſaturni. This cauſed a whitiſh cloudy precipitation of a reddiſh tinge, as in the Experiment with the Bath Waters.

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* To one ounce of the diſtilled water uſed here, was added ſix drops of ſolution of ſilver. This induced a ſlight milkineſs, as in Experiment VII. with the hepar ſulph. c. calce viva.

EXPERIMENT X.

ACIDS.

SP. VITR. NITRI, &c. SALIS.

Part III. To two ounces of the mixture as above, was added five drops of the vitriolic, nitrous, and muriatic acids, without cauſing the leaſt efferveſcence, precipitation, or change of colour.

EXPERIMENT XI.

SOLUT. *of* CORR. SUBL. *in* WATER.

Ten drops of a ſaturated ſolution of corroſive ſublimate were added to two ounces of the mixture as before. A blueiſh white cloud was immediately precipitated, and a thin film floated on the top, as in Experiment XXVIII. with the Bath Waters.

EXPERIMENT XII.

SOLUT. *of* MERCURY *in the* NITROUS ACID.

To one drachm of the original preparation, diluted with one ounce of diſtilled water, was added fifteen drops of ſolution of mercury in the nitrous acid. This cauſed a ſlight reddiſh white precipitation, which remained in the middle of the liquor, but did not ſubſide.

EXPERIMENT XIII.

With the RESIDUUM *depoſited on ſtanding, by the Solution of* HEPAR SULPH. *with* QUICK-LIME.

Six grains of a whitiſh equable reſiduum depoſited by the ſolution of hep. ſulph. c. calce viva, on ſtanding, were collected. Two grains of this were laid on a red hot iron, it fumed ſlightly, but gave no blue flame, ſparkles, or detonation, nor emitted the leaſt ſulphureous ſmell, though carefully obſerved. The reſiduum, on burning, changed from a white to a light aſh colour.

N.B. This Experiment was ſeveral times repeated.

EXPERIMENT XIV.

Ten grains of the above reſiduum were collected and carefully dried with a very gentle heat. To this were added five drops of the vitriolic, nitrous, and muriatic acids. It effervеſced ſtrongly with each of theſe, and with the vitriolic formed a ſaline ſubſtance, which appeared, from its taſte, *&c.* to be ſelenites.

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EXPERIMENT XV.

VEGETABLE BLUES *with the* SOLUT. *of* HEP. SULPH. *with* QUICK-LIME.

PART III. A piece of writing paper ſtained with the blue leaves of violets, and another with the purple of polyanthus flowers, was immerſed in a quantity of the mixture diluted as above, and freſh made. No change of colour happened. The ſame Experiment was tried with it after having ſtood expoſed to the air ſome time, when it immediately changed them to a green colour.

EXPERIMENT XVI.

Two ounces of the mixture were added to an equal quantity of the Bath Water without any obſervable change.

From a review of the above Experiments, it appears that moſt of them correſpond in effect with thoſe made with the Bath Water; and in thoſe where the appearances differ, I think the variation is owing to ſome other ſubſtances, which are known to form the impregnation of the Bath Waters, beſides the foregoing. In order to evince this the more clearly, I propoſe to give a ſhort comparative view of the effects produced by the ſame Experiments on the Bath Water and the artificial preparation, and then ſee if theſe different appearances may not be explained on the foregoing principles.

REMARKS *on the* COMPARATIVE EXPERIMENTS.

CAUSTIC ALKALI.

The effect of this ſeems nearly the ſame in both[*]. The cauſtic alk. ſeems to act in each, by decompoſing the hep. ſulph. c. calce viva, diſengaging the lime from the ſulph. and taking its place; which, however, as the cauſtic alk. ſupplies no fixed air, ſtill remains diſſolved in the water.

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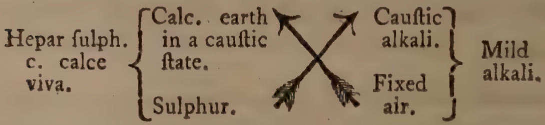
[*] Some ſmall precipitation happened in the artificial preparation, as well as in the Bath Water, probably owing to the alkali not being perfectly cauſtic, which is difficult to procure. The Bath Water exhibited a much larger precipitation when freſh, than after having ſtood ſome time, which proceeded probably from the quick-lime diſengaged by the alkali from the ſulphur attracting the fixed air ſuddenly, which we have before ſeen ſo plentifully contained in the water when freſh drawn, and being thus precipitated. This accounts for this circumſtance not being ſo obſervable in the water that had ſtood ſome time.

FIXED ALKALI *mild.*

PART III.

The hepar. ſulph. is here decompoſed, as in the foregoing Experiment, though the mild alkali is but very ſparingly miſcible with ſulphur. A double decompoſition, however, here takes place, which ſeems to effect their union. The quick lime attracts the fixed air from the mild alk. which is thus rendered cauſtic, and enabled to unite with the ſulphur, while the lime thus rendered mild, and of courſe inſoluble in water, falls down in form of a mild calcareous earth, and forms the copious white precipitation obſerved in the Experiment. This, however, will be better underſtood by the annexed ſcheme.



VOL. ALK. *cauſtic.*

The appearances ſhewn on addition of this ſubſtance, ſeem to be the ſame in both *.

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* It is doubtful here if the hep. ſulph. c. calce viva would be decompoſed, as the quick-lime ſeems to have a ſtronger attraction to ſulphur than the vol. alk. Probably the ſlight

VOL. ALKALI *mild*.

* The earth is here precipitated in both, for the reaſons given above, when I ſpoke of the fixed alkali, but not in ſo large proportion, as the vol. alk. is ſcarce ever got ſo mild as the fixed, and beſides does not contain fixed air in ſo large proportion.

LIME WATER.

The effects of this on the mixt and on the Bath Water when freſh, are totally different. With the former no perceivable effect was produced; whereas, with the latter, it occaſioned a copious precipitation. This difference, however, may be eaſily explained. The Bath Waters, when freſh, are known to contain fixed air in a large quantity, which the quick-lime in the water greedily attracts, and is thus rendered inſoluble, and, of courſe, precipitated. Probably the form

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ſlight precipitation (obſerved on ſtanding) in both was owing to the alk. not being perfectly cauſtic, which is very difficult, and, indeed, nearly impoſſible to procure, as it attracts fixed air from even a ſilver veſſel in which the evaporation is performed when wanted in a dry form.

* The hep. ſulph. c. calce viva ſeems to be here decompoſed by a double elective attraction, which may be underſtood by the ſcheme laid down in the foregoing page, only ſubſtituting the volatile in place of the fixed alkali.

PART III. of the precipitation, when an alk. and lime-water were uſed, is owing to this, that in the former the lime was ſeparated from the ſulphur, in the latter only precipitated from its ſimple ſolution in water.

What proves this more clearly is, that the precipitation is the largeſt when the lime-water is added to the Bath Water freſh drawn, and is ſcarce perceivable when added to the water that has ſtood ſome hours expoſed to the air *.

SOLUTIONS *of* SILVER *and* LEAD.

The event of the correſponding Experiments with theſe ſubſtances, turned out totally different, the ſolutions cauſing a large white precipitation with the Bath Water, whilſt they ſhewed ſcarce any effect on the other; and the ſmall degree of precipitation that was obſerved, was, in all probability, owing to ſome ſaline ſubſtance, perhaps the vitriolic acid, which it is difficult to get even diſtilled water free from. Thus much, however, we may reaſonably preſume, that the hepar ſulph. c. calce viva is not the ſubſtance that cauſes this effect. What produces that plentiful preciptation in the Bath Water, is undoubtedly the common ſalt, which, as was before obſerved in the ſmalleſt proportion poſſible, viz. of one grain to a gallon of water, will cauſe a milkineſs and precipitation with the ſolution of ſilver or lead.

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* It might be here alledged, that the precipitation was owing to the volatile vitriolic acid, which (as was before ſaid) there was reaſon to believe the preſence of in the water's forming a kind of ſelenites with the lime, which, as being ſo ſparingly ſoluble, would cauſe a precipitation. That this would equally account for the ceaſing of this effect on the water's ſtanding expoſed to the air, as the volatile vitriolic acid ſoon evaporates. This, however, cannot be the caſe altogether, as the precipitate efferveſced ſtrongly with even the vegetable acids. As, however, there is reaſon to ſuſpect the preſence of the volatile vitriolic acid, the precipitate might be compoſed of both theſe ſubſtances, *viz.* a ſmall part ſelenites, and the remainder a mild calcareous earth.

SOLUTION *of* MERCURY.

The difference of the effects produced on addition of this ſubſtance to the mixt and to the Bath Water, is very obſervable. With the former it exhibited a ſlight reddiſh cloud, with the latter a copious white precipitation. This, however, ſeems owing to the ſame cauſe as the foregoing. In the former, the ſolution of mercury ſeems precipitated by the vitriolic acid, which is ſeparated

PART III. ſeparated from the ſulphur by the attraction of the mercury, or by the decompoſition of the hepar ſulph. c. calce viva, in ſome degree, by its ſolution in water, which cauſes the precipitate to be of that reddiſh yellow colour, which is the ſame that mercury, precipated by the vitriolic acid, always aſſumes. In the latter caſe, the precipitation is certainly occaſioned by the common ſalt, the muriatic acid in it having a ſtronger affinity with mercury than the vitriolic acid has, which cauſes the difference of colour in the pecipitations. What confirms this is, that if a few grains of common ſalt be previouſly added to the mixt, the mercury is precipitated from the ſolution of a white colour.

SOL. of CORROSIVE SUBLIMATE.

The appearances in both caſes, on addition of this ſubſtance, ſeem nearly the ſame, and probably would have been exactly ſo, could we have brought the mixt to the exact ſtandard of proportion of impregnation with the Bath Waters.

ACIDS, VITRIOLIC, NITROUS, *and* MURIATIC.

The acids ſeem to have had no viſible effect on either the mixt or Bath Waters. The mixt, when freſh, ſeems to agree with the Bath Water, in its ſhewing little change at firſt in the colour of the vegetable blues, though when kept ſome time it exhibited the ſame effect. The Bath Water, indeed, when freſh drawn, ſeemed to change the vegetable blues to a little of a reddiſh caſt; but this was probably owing to a ſuperfluous quantity of the volatile vitriolic acid, which, as was before obſerved, there is ſome reaſon to ſuſpect the preſence of in theſe waters.

PART III.

From what has been before urged, and from the above compariſon of the Experiments, I think there is the greateſt reaſon to believe, that ſulphur, in this form, makes a part in the impregnation of the Bath Waters. I own, that all the comparative Experiments do not coincide, but thoſe which differ I hope have been ſatisfactorily explained to proceed from the effect of ſome other ſubſtance, whoſe preſence there we are aſſured of. The compoſition of

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the ſubſtance thrown up by the waters, called Bath ſand, being demonſtrated to be ſulphur joined to a calcareous earth, proves the poſſibility of ſuch an impregnation, and the agreement of the comparative Experiments made with an artificial compoſition of this kind, with thoſe made on the Bath Waters in all the material circumſtances, give, in my opinion, a rational proof of the exiſtence of this impregnation.

The proportion in each of the Baths cannot eaſily be aſcertained; I am inclined to think, that it is moſt prevalent in the Hot Bath, next in the King's, and leaſt in the Croſs Bath.

The next claſs of bodies that comes under conſideration, is that of metallic ſubſtances. The firſt of which, in the order they are placed in the table, is,

XIII. COPPER.

There does not ſeem to be the leaſt reaſon to ſuſpect the preſence of Copper in the Bath Waters. Iron immerſed in them is, indeed, ſoon corroded, but no precipitation reſembling copper is ever depoſited on its ſurface, as is the caſe with all waters that

contain

ontain that metal in a ſtate of ſolution. 'he Bath Waters ſeem, indeed, to have ery little effect on copper, as we ſee by he rings in the King's Bath for the athers to hold by, which are moſtly made f copper, and many of them, as appears y their dates, have continued near a century, and ſome of them longer, and ſtill emain little diminiſhed; whilſt thoſe of ron are entirely conſumed in a twentieth art of the time. The cauſtic volatile lkali likewiſe ſhews no ſigns of a cupreus impregnation, but mixes with the vater without any change of colour. No igns of this metal, in any form, apeared in the reſiduum left on evaporating he waters. The cryſtals there, were all olourleſs, and in taſte and effects by no neans reſembled the blue vitriol. On the vhole, we may rationally conclude, that his metal is not contained, in any form, in he Bath Waters.

XIV. IRON.

The preſence of Iron in the Bath Waters s univerſally acknowledged. The purple inge they ſtrike with ſolution of galls vhen freſh drawn, the ochrous incruſtations formed round the edges of the Baths which were ſhewed, by Experiment XIII to be reducible into iron; the Experiment made with the reſiduum of the waters lef on evaporation, and with the Bath ſand put this circumſtance beyond a doubt.

As to the form in which it is contained it appears to me to be diſſolved in th water by means of the volatile vitrioli acid. My reaſons are as follow:

Were it diſſolved by means of the fix vitriolic acid, the impregnation would b more permanent.

Hepar ſulphuris with an alkali does no exiſt in the Bath Waters, conſequently th chalybeate impregnation cannot be of tha kind.

Were it by means of the hepar ſulphuri with quick-lime, it would be likewiſe mor permanent. It may, indeed, be aſked, wh the Bath Waters ſhould loſe their chalybeate impregnation ſo ſoon, ſince they retain, even when grown cold, or after expoſure to the air for ſome time, a power o extracting a chalybeate tincture from iro filings? The cauſe I apprehend to be this

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That the metal is diſſolved by the vitriolic acid in its volatile ſtate, and on its flying off, falls down in form of calces not ſoluble in the water, by means of the ſulphureous menſtruum. It has been before obſerved, that the calces of metals are very difficult of ſolution. I am alſo inclined to think it not to be by means of fixt air, ſince an impregnation of the ſame kind, equally fugitive, may be imparted to diſtilled water, by means of the Bath ſand.

As to the proportion of this metal contained in the Bath Waters, it is undoubtedly very ſmall. Dr. Lucas has computed it at one thirty-ſeventh and a half of a grain of iron in a pint of the King's Bath Water, and this computation ſeems tolerably juſt. This circumſtance, however, as he very properly obſerves, is very difficult to be aſcertained with any great degree of exactneſs. The proportion of chalybeate in the other two Baths ſeems to be ſomewhat leſs, but in what degree I am not able to diſcover.

A curious queſtion ariſes on the ſubject of this impregnation, which I have not ſeen taken notice of by any other Writers, and which I own myſelf not able to reſolve ſatisfactorily, viz. why theſe waters do not give ſtronger proofs of a chalybeate impregnation than they do? It does not appear, on their analyſis, that they contain any ſubſtance that would precipitate the iron, were it contained in them in much larger quantities than it really is. And I find, in confirmation of the above opinion, that Bath Water, poured on filings of iron, diſſolves them plentifully; and it appears by the above Experiments, that even cold water extracted in a few minutes ſo ſtrong a chalybeate impregnation from the Bath ſand, as to ſtrike a deep black with ſolution of galls. Nevertheleſs, the Bath Waters, which, undoubtedly, paſs through many beds of minerals, containing this metal in large quantity *, and that too in a form capable of ſolution in water, exhibit but a very faint impregnation of this kind. This circumſtance ſeems difficult to account for. Perhaps it may be owing to the large proportion to, and ſwift paſſage of the water over the pyrites containing

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* Both theſe circumſtances may be reaſonably preſumed from the Experiments related with the Bath ſand.

PART III.

this metal. This, however, is not fully ſatisfactory, as it would hold equally ſtrong againſt all the other impregnations, ſome of which are contained in the waters in much greater proportion than the chalybeate one. I will venture, however, to ſuggeſt a circumſtance, which, though not of itſelf quite ſatisfactory, may yet throw ſome light on this ſubject. The learned Dr. Lewis gives an account of an Experiment, that has been related in the former part of this work, in which he found, that on addition of a fixed alkaline ſalt to a ſolution of green vitriol, no decompoſition enſued while the air was excluded, but that on its admiſſion, the acid and alkali preſently united. May not the volatile vitriolic acid, in like manner, exert but little effect on the ferruginous particles until the communication with the air is obtained, and then its ſwift paſſage may not afford opportunity for a more plentiful impregnation*?

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[*] It may be alledged, that this argument might be urged with equal force againſt all chalybeates whatever. Theſe, however, may ſome of them have acceſs to the air by ſome ſubterraneous paſſages, or caverns, ſimilar to thoſe mentioned in the account of the vitriolic acid *per ſe*, and its ſeparation by decompoſition from the pyrites, which may not be the caſe with the Bath Waters.

PART III. If this theory ſhould be blamed as too vague or uncertain, I beg leave to repeat the excuſe I have formerly made, which is, that I offer theſe things only as matters of conjecture, and this, I hope, will plead in behalf of mentioning them.

On the whole, then, the preſence of this metal in the waters is beyond a doubt, though its proportion there ſeems to be ſmaller than in any chalybeate I have examined.

XIX. ZINC.

The preſence of this mineral has never been ſuſpected here. Indeed (as has been before obſerved) it is a doubt if ever it forms a native impregnation of ſprings. However this may be, there does not ſeem to be the leaſt reaſon for thinking it makes any part of the compoſition of the Bath Waters. Its ſenſible qualities, and the effects it produces, even in very minute quantities, when diſſolved by the vitriolic acid, which is the form it muſt exiſt in, if at all, by no means coincide with thoſe uſually produced by theſe celebrated waters. Zinc, thus diſſolved, is poſſeſſed of emetic, and, at the ſame time, narcotic qualities, and theſe effects are produced by a very ſmall proportion of it. Theſe qualities, however, ill agree with thoſe of the Bath Waters, and the cure of thoſe diſorders, for which they are ſo much famed.

The cryſtals likewiſe procured on evaporation of the Bath Water have nothing of the ſweetiſh taſte, ſo remarkable in the white vitriol, and are likewiſe of more difficult ſolution in water. In a word, we have not the leaſt reaſon, either from the ſenſible qualities, or chemical analyſis of them, to ſuſpect that Zinc enters into their compoſition.

In the former part of this Work, I mentioned the three impregnations, above ſpoken of, as being all of the metallic kind, that were to be found native in Mineral Waters. Notwithſtanding, however, this aſſertion, which I believe to be juſt as to native impregnations, an accidental combination with another metallic ſubſtance, and that too not the moſt innocent with reſpect to the human body, may ſometimes take place in them, eſpecially in thoſe of the thermal kind.

LEAD.

LEAD.

PART III. The effects of Lead on the human body are well known. "Obſtinate conſtipations, violent colics, pains and contractions of the limbs, tremors and reſolutions of the nerves, and ſlow waſting fevers, are the conſequences of this metal taken internally, and of the fumes to which the workmen are expoſed* in the fuſion of this metal in the way of buſineſs;" and even the external application of ceruſſe has been known to produce this effect. This metal, however, is generally thought not to be ſoluble in the vitriolic acid, unleſs in a boiling heat; and this ſeems true with regard to the fixed; but as to the volatile, it is by no means to be depended on, as that will act on Lead in an inferior degree of heat; and though its attraction to metals does not ſeem to be ſo ſtrong, yet it diſſolves them in much larger proportion than the other.

After having given the above account of the effects of this pernicious metal, I ſhould be ſorry to inſinuate any ſuſpicion of its preſence in theſe ſalutary ſprings. Nevertheleſs, the ciſtern which ſerves as a reſervoir for the ſpring, at its firſt riſe, appears plentifully corroded on its inſide, by the long furrows which are viſible in every part of it. This proves the poſſibility of ſuch an impregnation, though probably its proportion there is too ſmall, or perhaps counteracted by ſome other qualities of the waters, to work any obvious effects on the human body. But this is by no means a juſtification of the uſe of any thing liable to give an impregnation of this ſort, in the ſlighteſt degree. A portion of ſeveral metallic ſubſtances, almoſt too minute to be diſcerned, is capable of working great changes in the human frame; and, among theſe, Lead claims the chief place, and is, perhaps, the moſt dangerous, as it frequently works by ſlow, and almoſt imperceptible degrees, and has often compleated the miſchief, before the perſon was ſenſible of his danger, or to what cauſe to attribute his malady *. The noted colic at

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* Lewis's Mat. Med. Art. Plumbum.

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* Nec minus infælices qui aquam plumbo divitem bibunt. Plumbeis ædes tectæ laminis, ubi pluvialis ſola bibitur, in ciſternis collecta, vel in plumbeis ſervata vaſis, quod peſſimum, frequentiorem multò faciunt morbum: et hæc eſt ratio quâre inſolitus olim colicus dolor, graſſetur nunc Amſtelodami.

Tegulis

PART III.

Amſterdam was of this kind, which, for a long time, eluded the ſearch of the learned with reſpect to its cauſe; and it ſeems probable, from ſome ingenious experiments by Dr. Baker, and others, that the Devonſhire Colic proceeds from the ſame origin. If to this it ſhould be objected, that we have no accounts of any ſuch effects produced by the Bath Waters, and that, on the contrary, they have been proved to be very efficacious in the cure of theſe very diſeaſes, we may reply, that the action of the water on this metal has been ſufficiently proved, and that it is poſſible that the unfavourable ſymptoms ſometimes produced on drinking them, which we know not how to account for otherwiſe, may be produced by ſome ſuch impregnation; as this metal, though its

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Tegulis anteà tectæ, hodie plumbo teguntur ædes, ſupernè olim declives, nunc planæ. Volitantia ſub finem autumni folia decidua, viridarium enim crederetis urbem, ventis in tectæ feruntur, macerata ibi aquâ ſtagnante, hanc inficiunt acore, quo ſolutum plumbum in ceruſſam abit, ad ciſternam dein rapitur imbre, ſic ſenſim inficitur aqua. Nec mirum ſi in aliis locis ubi deficit plumbum, arboreſque deſunt, minùs frequentes ſint colici dolores. Hinc intelligitur quâre ſi cadentibus foliis tenues nullæve ſint auræ, ſi cautè ligno tegatur plumbum, ſalubrior aqua ſit. Fidem obſervata merentur, vidi malum in integras ſæviiſſe familias. Undecim in unâ domo uno tempore decumbentes, horrendis cruciatibus convulſi, membris ſoluti, mutato tecto, renovatâ aquâ, convaluere.—TRONCHIN, *de Colica Pictonum, Art.* 10, *p.* 66, 67.

effects are ſometimes latent, is ſeldom inactive. It may be, perhaps, owing to this cauſe, that ſome diſorders of the ſpaſmodic kind, as the Opiſthotonus, ſeem ſometimes rather enhanced by drinking the Waters, when bathing alone is of great ſervice. This may likewiſe occaſion the retardation, and ſometimes the failure of cure, of many bowel diſorders; and the obſtinate coſtiveneſs * ſo much complained of on drinking the Bath Waters, which is a conſtant effect of that mineral, makes this conjecture not improbable. Effects, when ſlowly produced, and the reaſons not ſelf evident, are often neglected, or attributed to unavoidable cauſes, or circumſtances to which they do not belong. The noted Colic at Amſterdam had many cauſes aſſigned for it before the true one was diſcovered, and it is poſſible that this quality in the Bath Waters may not be originally inherent in them, but perhaps owing to ſome accidental circumſtance of this nature.

From an examination of their contents, I can diſcover nothing to which this effect

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* The waters of the Hot Bath are obſerved rather to open than bind the body. The reſervoir there is made of ſtone.

can rationally be aſcribed; and if we reaſon from analogy, all the ſulphureous preparations tend rather to looſen than bind the body.

An eminent and ingenious Writer has cautioned againſt the uſe of Lead in our common pumps; as he ſays, that although Lead may not be obviouſly ſoluble in common water, that a portion of it may be abraded, and ſo minutely comminuted * by the working of the pump, as to be ſuſpended in water, and thus capable of being received into the human body. If this caution was well founded, as to laying aſide the uſe of Lead in common pumps, how much ſtronger will it be applicable in this inſtance, where the pump is worked daily many hours together, and the abraſion conſequent on it, proportionably greater, and the very water drawn by it, capable of corroding, if not holding it in a ſtate of ſolution?

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* There is great reaſon to think that this circumſtance would increaſe the ſolubility of lead very much. Common flint glaſs, as we generally ſee it, is inſoluble in any menſtruum, yet, when finely ground down, is ſoluble in part in acids, and imparts to them a leaden impregnation.

If it be farther alledged, that no Lead appears to be found in the waters * by experiment, it may be anſwered, that this metal is ſufficiently proved to be acted on, by the effect before-mentioned to be produced on the reſervoir; and though the proportion contained in any quantity of water capable of coming under our examination, might elude a diſcovery by a chemical analyſis, yet its effects on the human body might poſſibly be ſtill exerted. This was the caſe at Amſterdam before quoted, where, though the diſorder was undoubtedly owing to this cauſe, and its proportion vaſtly larger than it could be in this inſtance, it was ſtill ſo minute as to be ſcarce diſcoverable by a chemical examination.

On the whole, when we conſider the nature of thoſe diſeaſes which are generally recommended to theſe waters for relief, which are † many of them of the

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* It is not improbable, that the decompoſition of the tinctura ſulph. volat. mentioned by Dr. Lucas, which I find, on repetition of the ſame Experiment, to be true, may be owing to ſome degree of an impregnation of this kind.

† Many minute circumſtances, which perhaps might have ſcarce any perceptible effect on a perſon in health, might be of the worſt conſequence to thoſe who are already prediſpoſed to diſorders of this kind.

PART III. ſame kind with thoſe occaſioned by this pernicious mineral, and not a few actually produced by it, we ſhall then ſee the peculiar propriety of avoiding any poſſibility of an impregnation of this nature. I would therefore humbly, though earneſtly, recommend to thoſe, who are the guardians of theſe antient and juſtly celebrated fountains, to ſubſtitute a reſervoir of marble, or, what perhaps may be full as proper, of grit ſtone, in place of the leaden one now uſed, and wooden, or, what may ſerve the purpoſe ſtill better, caſt iron pipes for the ſupply of the pumps*.

EARTHY SUBSTANCES.—SIMPLE.

XX. CALCAREOUS EARTH.

I mentioned, in the former part of this Work, that there was but one kind of earth that was ever found, in its ſimple ſtate, native in ſprings, in ſufficient quantity to bring them under the definition of

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* I have the ſatisfaction of finding this piece of advice approved of by ſeveral of the moſt eminent of the Faculty, among whom I am happy in mentioning Dr. Dealtre, of York, Dr. Wall, of Worceſter, Dr. Cuming, of Dorcheſter, Dr. Percival, of Mancheſter, and Dr. Haygarth, of Cheſter.

Mineral Waters, and this is the Calcareous. Whether this enters into the compoſition of the Bath Waters, in its cauſtic ſtate, and uncombined with any other ſubſtance, is a curious queſtion. The copious precipitation of a calcareous earth, conſequent on the addition of a mild alkaline ſalt, would lead us to imagine this to be the caſe, as this always happens on its being added to lime water.

Though I do not deny that a ſmall proportion of calcareous earth, in form of lime, may be found in the Bath Water that has ſtood ſome time, which is rendered ſtill more likely by the greeniſh tinge the water gives to the vegetable blues in theſe circumſtances; yet we have no reaſon to think any ſuch ſubſtance is united to them when freſh, as they then ſeem to give proofs rather of an acid impregnation *. The ſigns they ſeem to give of an impregnation of an alk. nature, may be owing to the decompoſition of the hep. ſulph. c. calce viva contained in the Water, cauſed by the flying off of

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* Vide Experiment XXXI. where it is ſaid to change the vegetable blues to a reddiſh tinge.

PART III. part of the acid, and leaving a ſuperfluous quantity of the calcareous earth, in form of quick lime, united with the water. By the above Experiments it appears, that the hep. ſulph. c. calce viva anſwered all the teſts above mentioned, which are commonly accounted proofs of the preſence of a calcareous earth. The manner that this comes to paſs has been above explained, when I treated of that ſubſtance*. Nor is there more reaſon to think that calcareous earth is contained in the Bath Waters, by being united with an over proportion of fixible air, according to Mr. Cavendiſh's theory, ſince, if this were the caſe, it muſt depoſit the earth immediately on the evaporation of the fixible air, which is not the caſe.

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* The calcareous earth, left on evaporation of the Bath Waters, might countenance the opinion of its preſence there in a ſeparate ſtate. This however may happen, and is probably occaſioned by the decompoſition of the hep. ſulph. c. calce viva, which, on ſtanding expoſed to the air, and more eſpecially by ſtrong boiling, ſuffers a decompoſition, and of conſequence ſeparation of its parts; the vol. vitr. acid and phlogiſton being diſſipated, and the calcareous earth precipitated in a mild ſtate. Selenites too, which is largely contained in theſe waters, undergoes, in the ſame circumſtances, a ſimilar decompoſition, and may in part occaſion this appearance.

The precipitation which occurs on the addition of lime water, is probably owing to the calcareous earth, precipitated from the lime water itſelf, by the fixed air in the Bath Waters, and never originally contained in the waters themſelves. This is farther proved, by no precipitation happening in the waters, on addition of lime water, after they have ſtood ſome time, even though no ſpontaneous earthy precipitation has taken place.

We may then ſafely conclude, that Calcareous Earth is not found native and uncombined with any other ſubſtance in the Bath Water.

XX. EARTHY SUBSTANCES.—COMPOUND SELENITES.

Though I cannot allow that Calcareous Earths *per ſe* have any ſhare in the compoſition of theſe waters, I own that, in their compound ſtate, they form one of its principal impregnations. Combined with acid, in form of Selenites, they are undoubtedly contained in the waters, as appears plainly from the cryſtals left on evapo-

PART III. evaporation, which were of * an hexagonal priſmatic form, of ſmall ſize, nearly inſipid, and ſcarce perceptibly ſoluble in water. To this impregnation the curdling of ſoap may poſſibly be owing, though that may be produced by the hepar ſulph. cum calce viva †.

On the whole, the foregoing Experiments ſufficiently prove the preſence of this ſubſtance, though it does not ſeem to have any great effect in compoſing the medicinal qualities of the waters.

XXIII. SAL CATHARTICUS AMARUS.

The next body that comes under conſideration, is the Spurious Glauber's Salt, or

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* Selenites is deſcribed by many authors[a], who have wrote on the Cryſtals of Salts, as cryſtallizing on the ſurface of its menſtruum in theſe laminæ. This, however, is only a miſtake, ſince it only happens when the evaporation is carried ſo far as to form a pellicle on the ſurface. In that caſe it cryſtallizes in a ſeemingly laminated form. But, on microſcopical examination, even theſe appear to be compoſed of hexagonal priſmatic cryſtals, though ſmall and irregularly formed, occaſioned by their running into cluſters, by too haſty a cryſtallization. By a judicious management of the heat, and ſometimes by addition of a ſmall quantity of rectified ſpirit, towards the end of the evaporation, ſelenites may be brought to form, in fair and well ſhaped cryſtals, at the bottom of the veſſel.

† Vide note on Experiment II.

[a] Lewis's New Diſpenſatory, p. 461. edit. 2.

Sal cath. amar. There does not however ſeem to be the leaſt reaſon to authorize our belief of its preſence in the Bath Waters. Their taſte by no means reſembles thoſe of this kind, and the reſiduum left on evaporation gives not the leaſt ſign of it. Were this ſalt contained in the waters, it might be eaſily detected by this means, as the vitriolic acid is not ſeparated from magneſia by the heat neceſſary for the evaporation, and then the hexagonal priſmatic form, bitter ſaline taſte, large ſize, and eaſy ſolubility of its cryſtals, would ſoon diſtinguiſh it from all others of this kind. The cryſtals, indeed, which appear, on the evaporation of the Bath Waters, are of the ſame form with thoſe of the magneſia, Glauber's ſalt, and in ſome degree of a ſaline bitter taſte, as all ſalts that have vitriolic acid in their compoſition are, but that is extremely ſlight in compariſon with the other. They are likewiſe of ſmall ſize, and not ſoluble, unleſs in a very large proportion of water, which ſufficiently diſtinguiſhes them from thoſe of the Sal cath. amar. which is ſoluble in as ſmall proportion of water as any ſaline ſubſtances we are acquainted with.

XXIV. ALUM.

The next ſubſtance that preſents itſelf to my enquiries is Alum. The Bath Water, when nearly evaporated, has ſome degree of an auſtere bitter taſte, but does not poſſeſs that nauſeous ſweetiſh one which is always inherent in Alum. A ſolution of a fixed alkaline ſalt cauſes, indeed, a white precipitation, but by no means in the flocculous form in which the earth of Alum is always precipitated, nor is any part of the precipitate re-diſſolved, which is always the caſe when the fixed alkali is not added in ſufficient proportion to ſaturate the ſuperabundant acid contained in the Alum. Add to this, that the earth of Alum is equally precipitated by cauſtic as mild alkalies, which is not the caſe with the Bath Waters.

On examination, likewiſe, of the reſiduum of the Bath Waters, no marks of Alum are to be found; the ſaline particles are all hexagonal, or cubical, and of ſmall ſize; whereas Alum, as was before obſerved, ſhoots into large angular maſſes, conſiſting of eleven planes, five of which are hexagonal, and ſix quadrangular. Alum likewiſe is much more ſoluble in water than ſalt thus obtained, the former requiring only about ten times its weight of water to diſſolve in, but the latter infinitely more. On the whole, we have no reaſon to think Alum to be an ingredient in their compoſition.

AERIAL BODIES.

I now come to the laſt head of impregnations, viz. Aerial Bodies; of theſe the firſt mentioned in the Catalogue is Common Air.

XXVI. COMMON AIR.

This ſeems to be very ſparingly contained in the Bath Water when freſh *, as fewer bubbles are obſerved in it, when placed under the exhauſted receiver †, than in water that has ſtood ſome time expoſed

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* This Experiment was tried with the water taken up from the Bath. When the water from the pump was uſed the event was different.

† Though the Bath Waters freſh from the ſpring ſhew but little marks of their containing Air by the Experiment mentioned above, yet, when grown cold, and having been expoſed ſome time to the air, it exhibits the ſame appearances with common water.

PART III. to the atmoſphere. This obſervation may, indeed, be applied to many ſprings, as they are all found to contain it in leſs quantity when freſh, than after remaining ſome time in an open veſſel. The air likewiſe contained in theſe waters muſt be highly rarefied by their heat, inſomuch as to be diſſipated nearly on their firſt communication with the atmoſphere, before it could be poſſible to make them the ſubjects of experiment. Thus we ſee common water, that has been boiled, or ſtrongly heated in an open veſſel, gives, for ſome time after, very little marks of containing air, exhibiting few or no air bubbles under the exhauſted receiver, and freezing without any increaſe of bulk.

I am inclined to believe, that a conſiderable quantity of Common Air is united with the Bath Waters mechanically in their fall from the pipe, and that to this is owing, in ſome degree, the number of air bubbles, which we ſee adhering to the ſides of the glaſſes when juſt filled. I have myſelf obſerved, in confirmation of this, that theſe were not near ſo numerous when the water was taken up, by immerſing a glaſs into the ſpring head, in the manner as at Tunbridge, although the taſte was at leaſt equally poignant, and all the other ſenſible qualities equally remarkable. Although this ſubſtance can hardly be ſaid to enter into their compoſition at their firſt riſe, yet, as it is always united with them in the ſtate in which they are offered to us, and as its preſence there is probably by no means unimportant, I cannot refuſe it a place in the catalogue of Impregnations.

XXVII. FIXIBLE AIR.

Although Common Air ſeems to be contained in the Bath Waters but in ſmall proportion, this is by no means the caſe with the Fixed or Mephitic Air, whoſe preſence here is very evident, and is probably one of the greateſt ſources of their admired qualities. The ſparkling appearance, pungent taſte, and, on many, if taken in large quantity, inebriating effects, are ſufficient evidences of this. Perhaps, likewiſe, the odour, mentioned by Dr. Lucas as prejudicial to weak lungs, and of an * acid pungency, might be more owing to this than to the volatile vitriolic acid, to which it is uſually attributed. Theſe indeed may be very eaſily miſtaken for one another, as it is not improbable that an acid is always either united with, or makes part of, the compoſition of Fixed Air; ſince even that, when accumulated in large quantity, as on the ſurface of fermenting liquors, is found to change the colour of vegetable blues to red.

Chemical Experiments likewiſe confirm our opinion of this impregnation, which their ſenſible qualities had indicated. The precipitation of the lime from lime water, on admixture of the Bath Water, when freſh, and the ceaſing of this effect, on its ſtanding expoſed to the air, the film produced on the ſame by the ſteam of freſh drawn Bath Water, conveyed by a bended tube on its ſurface, prove this very clearly. To this likewiſe is owing the burſting of the bottles, if corked up as ſoon as filled

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* Dr. Percival found, that the air produced from an effervefcent mixture of earths, or alkaline ſalts, with the vitriolic acid, was in ſome degree offenſive to reſpiration, which was not the caſe when the vegetable acid was uſed.

from the ſpring, and in ſome degree the ſenſible diminution of the bulk of the water, on ſtanding a few minutes expoſed to the air. To this, however, it may poſſibly be objected, that if the Bath Water contained Fixed Air in large quantity, its effects on the human body, ſo far from being ſalutary, muſt be highly prejudicial, ſince that ſubſtance is known to cauſe deleterious and even fatal effects; witneſs the many accidents that have happened from too near an approach to a veſſel of fermenting liquor, whoſe effluvia, which we know to be compoſed principally, if not altogether, of Fixed Air, produce the moſt ſudden and fatal conſequences to animal life that we are acquainted with.

PART III.

In anſwer, however, to this, we may alledge, that although I own the effects of* ſome

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[*] It has been lately diſcovered, by my learned and ingenious friend Dr. Percival, of Mancheſter, that Fixible Air differs greatly in its effects, according to the different ſubſtances from which it is procured. That although ſome kinds of it are ſuffocating and deleterious, others may be reſpired with ſafety, even when largely accumulated, and are ſo far from proving injurious to the lungs, that they furniſh a powerful remedy in ſeveral of the diſorders of thoſe organs. Probably the Fixible Air contained in theſe waters is of ſome of thoſe kinds which are innocent, or leaſt injurious to animal life.

PART III. ſome kinds of Fixed Air, when accumulated in large quantity, to be as thus repreſented, yet, when united with a certain * proportion of common air, it becomes harmleſs, and may be even reſpired with ſafety. It is remarkable of Fixed Air, that its pernicious effects ſeem chiefly exerted when taken in by reſpiration, and that the ſame ſubſtance which, received into the lungs ſhould induce an almoſt inſtantaneous † paralytic torpor on the vital organs, ſhould, when taken into the ſtomach, prove a powerful and invigorating ſtimulant.

The celebrated effects of theſe waters, in reſtoring weak ſtomachs, and enabling them to retain food, are, in all probability, owing to this part of their impregnation,

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* Perhaps to this admixture it is owing, in ſome degree, that the effluvia of the Bath, and other Waters, which contain Fixed Air in ſubſtance, do not, when taken in by reſpiration, exert any of the pernicious effects on the human body, belonging to this ſubſtance, in its ſeparate ſtate.

† This is to be underſtood of it only as taken into the ſtomach in a certain proportion, as even there, if accumulated in too great quantity, it exerts its effects ſimilar to thoſe produced by it, when taken in by reſpiration. Thus a ſmall quantity of rectified ſpirits (for the time at leaſt) ſtimulates and invigorates the ſtomach and powers of digeſtion, but if taken in over proportion, debilitates and hurts their faculties, and if the quantity be very large, induces a ſudden paralytic torpor of all the vital powers.

To the diſſipation, likewiſe, of this volatile ſubſtance may be aſcribed the ſmall effects which theſe waters produce when drank cold, or at a diſtance from the ſpring, compared with thoſe produced by them when freſh.

The common ſaline mixture, called, from its effects antiemetic, affords a ſtriking analogy to the effects of Bath Water in this reſpect, as this was found to exert none of its antiemetic qualities, unleſs taken during the efferveſcence; and by the account given of it by Sir John Pringle, its * antiſeptic effects were much more obſervable, when taken in this manner, than after that had ceaſed. For this reaſon that learned and judicious practitioner has delivered an elegant formula for the exhibition of this preparation in the act of efferveſcence, whereby its effects of this kind may be beſt preſerved.

On the whole, we may be aſſured, that Bath Waters contain Fixible Air in conſiderable proportion, and, probably, of the moſt innocent kinds. The King's Bath

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* This is likewiſe confirmed by Mr. Macbride's Experiments.

PART III.

ſeems to contain it in greateſt quantity, and the Croſs Bath the leaſt.

From a review of the above reaſoning and experiments, I find, that out of the ſubſtances which are mentioned as poſſible native impregnations of Mineral Waters, thoſe of Bath contain the following.

TABLE *of the* CONTENTS *of the* BATH WATERS.

1. Saline bodies.	Simple. 1. Vitr. acid per ſe, very dubious. Compound. 2. Common ſalt in ſmall quantity.
2. Inflammable bodies.	3. Hepar ſulph. cum calce viva, in large quantity.
3. Metallic bodies.	4. Iron.—One thirty-ſeventh and a half of a grain in a pint of the water.—Lucas. 5. Lead.—Qu. if this is not an accidental impregnation?
4. Earthy bodies.	6. Selenites in large quantity.
5. Aerial bodies.	7. Common air, probably both in ſolution or mixture and diffuſion. 8. Mephitic air in large quantity.

PART IV.

APPLICATION *of the* WHOLE *to the* PURPOSES *of* MEDICINE.

PART IV.

I COME now to the laſt and moſt important part of this Work, which is, to give ſome account of the *purpoſes to which the Bath Waters may be applicable in Medicine.* This I intend to conſider under two heads; the firſt of which I propoſe ſhall contain a deſcription of the general effects of the Bath Waters (when drank) on the human body, with ſome conjectures concerning the peculiar impregnation to which theſe effects may be owing, and ſome remarks on the different qualities of the ſeveral waters, and on the probable cauſe of theſe variations.

I ſhall next make a ſhort application of the foregoing to particular Diſeaſes, and ſhall ſubjoin a few obſervations on the caſes in which they are contraindicated, or where their uſe would probably be prejudicial, or at leaſt of no ſervice. This I ſhall endeavour to deduce from the known

PART IV. effects of the waters on the human body, and the propriety, or impropriety, of uſing medicines calculated to anſwer ſuch indications in ſuch complaints.

I ſhall add, laſtly, a ſhort abſtract of thoſe ſpecies of Diſorders in which theſe waters have been found of ſervice in practice, and of thoſe which, from analogy or reaſon, we might imagine likely to be relieved by them.

This laſt part is addreſſed principally to the Faculty, and I have taken the liberty of making uſe of Dr. Cullen's ſyſtem, as contained in his Synopſis, lately publiſhed, which is the moſt clear and comprehenſive of any that I have ſeen.

The candid reader will ſcarce expect a full diſcuſſion of the above articles in a Book of this kind. I mean no more than to offer my ſentiments in general, and have made choice of the above-mentioned plan, only for the ſake of reducing them to method. I am conſcious that to treat the ſubject as it deſerves would require a much greater ſhare of abilities than what I can pretend to, and would, moreover, be too voluminous a work to be comprized within ſuch narrow limits. All I aim at here, is to give a ſhort abſtract of the Qualities of the Bath Waters, and of the Diſorders in general to which they are principally adapted; and I flatter myſelf, that this Work may not be entirely uſeleſs, if it ſerves only as a ſketch of a plan on which ſome future Writer may enlarge.

Such is the plan of the firſt Chapter of this diviſion of the Work, which may, in ſome reſpects, be called the *Medical* Part.

In the ſecond Chapter, which may be called, though perhaps not ſtrictly, the *Pharmaceutical* Part, I propoſe to treat of the methods by which theſe waters may be beſt managed, ſo as to anſwer, moſt ſucceſsfully, the above indications in the cure of diſeaſes. This I propoſe to purſue in the following order:

1. As to the choice of the waters.
2. The ſtate of the waters when drank.
3. Quantity.
4. Time of day.
5. Length of time proper for them to be continued.
6. Seaſon of the year beſt adapted to their uſe.
7. Regimen of life.
8. Subſtances proper to be uſed at the ſame time with the waters.

CHAP. IV.

SECT. I.

On the general Effects of the BATH WATERS.

PART IV. THE firſt quality of the Bath Waters of which I ſhall ſpeak, as being the moſt obvious, is their ſtimulant * one.

Their heat, briſk and poignant taſte, and, if largely taken, inebriating effects, are great evidences of this, which are confirmed by their effects on the ſyſtem. They accelerate and raiſe the pulſe, increaſe the heat, and excite the ſecretions. So far as to their general effects.

But it may be doubted, if they do not poſſeſs a ſtimulus of a peculiar kind. The glowing ſenſation in the ſtomach perceived on drinking them, the ſudden increaſe of ſtrength often procured by their means, and, if too largely taken, the pain in the head which they occaſion, indicate, that they are poſſeſſed of a degree of ſtimulus of a particular nature, principally affecting the nervous ſyſtem, and not to be meaſured entirely by the pulſe, heat, or increaſe of ſecretions, ſince theſe are often not proportionally affected. This is, in my opinion, confirmed, by obſervation of the effects they produce on the ſtomach and appetite, when the ſtrongeſt ſtimuli of other kinds had been tried in vain.

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* By Stimulants I mean ſuch ſubſtances as excite the motion of the fibres in living animal bodies. All thoſe medicines that go under the name of cordial are of this kind.

PART IV.

From their immediate action on the body, it appears probable, that they act in this way through the intervention of the ſtomach, to which their ſtimulus ſeems in a manner ſpecific. This quality is common to all the ſprings, but poſſeſſed in leaſt degree by the Croſs Bath Water, and in the higheſt, as is generally thought, by that of the King's Bath. This varies in ſome habits, but this difference is more probably owing to peculiarity of conſtitution, than any inherent quality of the waters.

To what this quality may, with moſt probability, be aſcribed, comes next to be conſidered.

In my opinion, it is principally owing to its *aërial* impregnation. I do not deny that the chalybeate, and perhaps the ſulphureous parts of the impregnation, and the heat of the water itſelf, may have ſome ſhare, and, moreover, the junction of all theſe with the ſaline qualities, may form an united ſtimulus, different from what any of them would have exerted when ſeparate; but I am ſtill inclined to think, that the fixible air is the chief agent, and prime ſource of this quality. The chearfulneſs, and, if too largely drank, inebriating effects, ſimilar to thoſe we ſee follow the drinking fermented liquors, which are produced by theſe waters when freſh, and the loſs of theſe qualities on ſtanding, prove very plainly, that theſe effects are owing to a volatile part of the impregnation. The water, indeed, on ſtanding, ſoon loſes the chalybeate impregnation likewiſe; but this is too inconſiderable to have ſuch powerful effects attributed to it. The water, indeed, on ſtanding, ſeems to ſuffer a decompoſition, and, conſequently, a change of nature of the ſulphureous impregnation alſo; but it loſes its ſtimulant quality, in a great degree,

gree, before any ſigns of this appear. The aërial impregnation then appears to be the only one to which this quality can be aſcribed, as it is a volatile ſubſtance itſelf, and agrees in effects, in a great meaſure, with thoſe produced by theſe waters.

In all probability, the King's and Hot Bath are more ſtimulant than the Croſs Bath, on account of their being more largely impregnated with this ſubſtance.

Another quality which the Bath Waters poſſeſs, is that of *aſtringent*. This is proved by their effects on the human body, coſtiveneſs being a very common circumſtance attendant on their uſe. It is not improbable, likewiſe, that their effects in reſtoring the tone of the ſtomach and bowels, may in ſome degree be owing to this quality. Whether theſe waters be directly aſtringent, or whether they are only conſequentially ſo on the bowels, owing to their increaſing the heat, and raiſing and accelerating the pulſe, and increaſing the other ſecretions, perſpiration particularly, is a doubtful caſe. I have ſome doubts if the King's Bath Water be not in its nature aſtringent, for the reaſons

Part IV. given in the third * part of this Work; but, excluſive of this, I doubt, whether any of them have much claim to ſuch quality, except in a ſecondary view. But as they all are frequently found to exert this effect ultimately, it cannot well be denied that they have ſome title to the appellation. To what this quality in the waters is owing is difficult to aſcertain. The King's Bath, which is moſt remarkable in this way, has been mentioned as lying under a ſuſpicion of ſome impregnation with lead, which, if well founded, would amply account for this quality. I confeſs I am not fully ſatisfied that they do not all partake of a ſimilar impregnation, though perhaps not in ſuch a degree, ſince leaden pumps and pipes are common to all; though in the Hot, and, I believe, the Croſs Baths, the ciſtern is made of ſtone.

The chalybeate impregnation, likewiſe, may act in this way, but this is too ſlight to act ſo powerfully as is obſerved here. The heat, likewiſe, and ſtimulant qualities of the waters (dependant on the fixi-

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* Vide article Lead.

ble air) promoting urine and perſpiration, PART IV. muſt, as was before obſerved, of conſequence diminiſh the evacuation by ſtool; and though I do not imagine any of the impregnations, of which we are tolerably well aſſured, can have any great power in this way, yet I will not abſolutely deny, that, when combined, they may, in ſome conſtitutions, act directly on the ſyſtem as aſtringents as well as ſtimulants.

The King's Bath is moſt remarkable for this quality, and the Hot Bath is generally thought to have the leaſt of it.

Whether this be owing to any impregnation of Lead * in the King's Bath Water, which I mentioned before, (which is not in that of the Hot Bath) as being to be ſuſpected, I cannot perfectly aſcertain.

The Bath Waters in general likewiſe poſſeſs the quality of being *diuretic*. This quality is well known to moſt of thoſe who have made trial of them, it being generally eſteemed one of the beſt methods of their paſſing off, and ſuch as generally indicates that the patient will receive benefit from their uſe. They ſeem to poſſeſs this quality with no great peculiar ſtimulus on either the ſecretory or excretory organs of urine. I once thought that their action in this way was, in a great meaſure, mechanical, and owing merely to the quantity of diluting liquor taken in; but I am now convinced that they are endued with a great degree of diuretic power, ariſing from their own particular impregnations; and this is confirmed by obſervation of their great evacuating effects in this way, in dropſical complaints, where a mere diluting liquor taken in large quantity would have had no ſuch effect, and by its bulk would be thought highly improper.

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* Vide Part the third, article Lead.

What this quality is owing to is next to be conſidered; and here again I am inclined to aſcribe their operation in this way principally to the fixible air. I do not deny that its ſtimulus is modified, and perhaps directed to the urinary paſſages by the ſaline part of the impregnation; but I am well ſatisfied that this effect is, in a great meaſure, owing to the fixible air, ſince I have obſerved, that the waters drank at home did not prove nearly ſo diuretic as when drank at the pump, although moderate exerciſe, by walking about in a cool room, was uſed with them. I have likewiſe been aſſured by ſeveral, that the Bath Water, when drank at a diſtance from the place, exerted very little effect of this kind upon them, although when drank at the pump it ſhewed it in a high degree.

But though I aſcribe a peculiar diuretic quality to the Bath Waters, I confeſs that their bulk, and the exerciſe generally uſed with them, I mean the walking in a cool air during the intervals of drinking, as is generally done in the pump room in a morning, contribute, very powerfully, to determine the waters to paſs off in this manner.

I have not been able to diſcover ſatiſfactorily, which of the ſprings poſſeſs this quality in the greateſt degree, though I think the Croſs Bath poſſeſſes moſt of it, probably on account of its being leaſt ſtimulant.

The Bath Waters are likewiſe *diaphoretic*. This quality of them is well known, as

PART IV. as well as the foregoing, and probably both are modifications of their ſtimulant quality. In general, when a warm regimen, and rather ſedentary manner of life is uſed, they prove diaphoretic; and when exerciſe, eſpecially walking in a cool air, as before-mentioned, is joined with their uſe, they paſs off by the kidneys. It is likewiſe obſerved, that their effects in this way are much directed by the weather. In warm ſeaſons they are much more diſpoſed (as indeed all ſtimulants are) to affect the ſkin than the urinary ſecretions, and the contrary is obſerved when the ſeaſon is cold. But though theſe are their general effects, yet they are much varied by the idioſyncraſy, or peculiar diſpoſition of the patient. I have obſerved ſeveral, who, having tried the waters in cool weather, and, perhaps, by that means given them a determination to paſs off by the urinary ſecretions, in whom this diſpoſition has not varied, even though the uſe of the waters was continued through a warm ſeaſon. In general it is obſerved, that a determination to the urinary paſſages, though often difficult to procure, is, when gained, the moſt fixed and certain of any, and perhaps to this is owing the difficulty of the cure of the diabetes.

This effect of the waters is, probably, owing to the ſame cauſe with the foregoing, being, in all likelihood, as I before obſerved, both of them modifications of their ſtimulant quality. The heat of them indeed ſeems to favour this ſecretion more than the diuretic one.

I have not been able to determine, ſatiſfactorily, in which of the ſprings this effect is moſt remarkable, though I think it more prevalent in the King's and Hot Bath than the Croſs Bath.

Another quality of the Bath Waters is that of being *antiſpaſmodic*.

I have not before obſerved, that this effect has been taken notice of as directly produced. Their efficacy in ſeveral ſpaſmodic and nervous caſes has been often remarked, but their effect in this way has been, I believe, aſcribed to their ſtrengthening the habit in general, reſtoring the ſecretions, and enabling nature to perform her ſeveral functions properly. But though I am well ſatisfied that they are of great ſervice in ſpaſmodic diſorders, by means of the above-mentioned qualities, I am convinced likewiſe that, in ſome caſes, they are directly antiſpaſmodic. This is proved by their immediate effect in the colica pictonum, and thoſe convulſive reachings which are often produced by the gout attacking the ſtomach, where their action is too immediate to be aſcribed to any other quality. This is corroborated by obſervation of the great effect of antiſpaſmodic medicines*, muſk particularly, in the ſame complaints.

To what this effect is owing is difficult to determine. To me it appears chiefly owing to the aërial part of the impregnation, which ſeems to poſſeſs qualities at once ſtimulant and ſedative, which is the foundation of moſt antiſpaſmodics. Perhaps the qualities of the fixible air in this way may be modified by the ſaline and ſulphureous parts of the impregnation. I think the Hot Bath poſſeſſes this quality in greateſt degree. Whether this is owing to its being more free of any leaden impregnation than the King's Bath, I ſhall not determine. PART IV.

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* Vide Eſſays and Obſervations, Phyſical and Literary, Vol. II. p. 250.

Another quality of theſe waters, which I have not ſeen remarked by any one, is that of being *antiſeptic*.

That they poſſeſs a property of this kind has been ſhewn by experiment*, and it does not ſeem improbable, that the good effects of the waters, in reſtoring weak and relaxed conſtitutions, may be in part owing to this quality, ſince a tendency to putrefaction is a very frequent attendant on a weak habit, and contributes, in its turn, greatly to favour the complaint.

The change of the conſiſtence of the fleſhy and muſcular parts of the body, from a ſoft and flabby to a † firm and hard one, which is an effect frequently produced by the Bath Waters, are great evidences in favour of this opinion.

What is the foundation of this quality remains now to be conſidered, and here I can have no doubt in aſcribing it principally to the aërial part of the impregnation, ſince fixible air has been found a powerful preventer, and even corrector of putrefaction, both which qualities ſeem to be poſſeſſed, in ſome degree, by the Bath Waters. The ſaline, and even chalybeate part of the impregnation, may, perhaps, have ſome effect in this way, but I imagine they are too ſlight to cauſe much perceptible difference.

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* Vide Experiments on the Bath Waters, Part III.

† Vide M'Bride, on the Powers of Antiſeptics.

By experiments, the King's and Hot Baths appear to poſſeſs this quality in a much greater degree than the Croſs Bath, which is, probably, owing to their being more largely impregnated with fixible air.

SECONDARY QUALITIES *of the* BATH WATERS.

Such are, in my opinion, the general qualities of the Bath Waters; but they alſo poſſeſs ſeveral others of a ſecondary nature, which are not ſo frequently exerted, and which likewiſe are either mechanical, or, in a degree, dependant on thoſe already mentioned. Thus, in caſes of viſcidity of the fluids, owing to their ſtagnation, from an inertia of the veſſels, or from retention of the proper excretions, Bath Waters, as exciting the motion of the veſſels, increaſing the ſecretions, and diluting the conſiſtence of the fluids in general, may prove *attenuant.* By their ſtimulant and aſtringent qualities ſtrengthening the ſtomach and organs of digeſtion, and preventing the fermentation of the food, they are frequently *antacid.* In caſes likewiſe, where, from weakneſs, the periſtaltic motion of the bowels is ſlow, Bath Waters, by their aſtringent and ſtimulant quality, reſtoring their tone, and exciting this motion, prove *cathartic.* This effect likewiſe is in part mechanical, owing to their bulk, and, in this way, ſimple water will have the ſame effect. In caſes likewiſe of the bilious kind, where, from ſpaſmodic conſtriction of the biliary ducts, the bowels are deprived of their accuſtomed ſtimulus, the bile, and of conſequence a coſtive habit, follows; Bath Waters, by relaxing the ſpaſm, gain a paſſage for that into the inteſtines, and prove in this way *purgative*, by means of their antiſpaſmodic quality.

Bath Waters, likewiſe, as increaſing the ſecretions by their ſtimulus, ſometimes promote, among the reſt, the ſecretion of mucus in the lungs, and are in this way expectorant *; and I think I have ſeen it do ſervice in this way, in ſome old gouty coughs, as promoting the criſis of the diſorder by theſe means. I have likewiſe ſeen it have this effect with advantage in the catarrhus ſenilis, and ſome other catarrhal complaints, not of the pulmonary kind, and unattended with heat or fever. Theſe waters likewiſe, as increaſing the ſecretions, promote the ſalivary diſcharge likewiſe. This effect I believe ſeldom happens in a great degree, though I have more than once ſeen it occur. In this light, then, they may be eſteemed *ſialagogue*.

Another effect of the Bath Waters is that of proving *emmenagogue*. This they produce by ſeveral means. The obſtruction of the menſtrual flux is frequently owing to, or attended with, a lax and weak ſyſtem of the uterine veſſels, and, in order to remove the obſtruction of it, it is always neceſſary to remedy the flaccidity. The Bath Waters then, as aſtringent and tonic medicines, are of great ſervice, as they reſtore the neceſſary conſtriction, which increaſes the impetus of the ſyſtem without inducing a ſpaſmodic affection. When this diſorder proceeds, as it often ſeems to do, from a languor and inertia of the ſyſtem in general, the Bath Waters are often efficacious in reſtoring this evacuation as *ſtimulants*, though I cannot ſay that I can diſcover any peculiar or ſpecific ſtimulus of this kind that they poſſeſs. I imagine, likewiſe, that the Bath Waters prove *emmenagogue* in another manner. This diſcharge, though often owing to a flaccidity of the veſſels, is ſometimes owing to a ſpaſmodic conſtriction; and here I imagine the Bath Waters, like muſk, caſtor, and the fœtid gums, act by their antiſpaſmodic quality.

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* Expectoration is ſometimes ſtopped or prevented by a ſpaſmodic contraction of the lungs. Perhaps in this caſe the action of the Bath Waters may be owing to their antiſpaſmodic quality.—*Qu.* Do not aſafœtida and gum ammoniacum owe their expectorant virtue to their antiſpaſmodic quality.

SECT. II.

On the INDICATIONS *to which the* BATH WATERS *are adapted.*

Having thus premiſed a general view of the effects of the Bath Waters, I ſhall now conſider the Indications to which they are adapted, with a ſhort application to particular diſorders, and ſhall ſubjoin likewiſe ſome obſervations on the caſes in which they are contraindicated, or where their uſe would probably be prejudicial, or at leaſt of no ſervice.

I ſhall purſue, in this application, the ſame order which I have done in treating of their effects.

The Bath Waters are in general indicated as ſtimulants, in caſes of languid motion, and this not only as merely the conſequence of weakneſs, but in many other caſes where the moving power of the ſyſtem is inert and ſlow. As this indication is the moſt extenſive, I ſhall conſider the effects of the waters as ſtimulants, and exerting this power under three heads: 1. Their effects on the ſyſtem of the blood veſſels. 2. Their effects on the nervous ſyſtem. 3. Their effects on the alimentary canal.

As to the firſt of theſe, the Bath Waters are indicated in caſes of permanent langour, ſuch as ariſes from, or is attended with, a ſlow circulation of the fluids. Of this kind are thoſe diſorders which go under the name of cachectic.

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The moſt ſimple of theſe is the Chloroſis incident to women, which ſeems to be owing to, or at leaſt always attended with, a ſlow motion of the veſſels. This diſorder is indeed ſometimes owing to a local affection of the uterus, but often to other cauſes likewiſe. In that ſpecies of it which is attended with paleneſs, diminution of ſtrength, and depraved appetite, the Bath Waters are generally ſucceſsful, and may be uſed in all caſes where chalybeate medicines are proper.

The Bath Waters are likewiſe of great ſervice in caſes where this inertia of the veſſels has increaſed to ſuch a degree as to produce obſtructions of the viſcera. Theſe appear to be frequently owing to this origin, eſpecially in the female ſex in general, and often happen in conſequence of neglect of the former complaint. The parts generally affected in this way are, the liver and meſenteric glands, and ſometimes the ſpleen.

In all theſe, if uſed before the inflammatory diſpoſition takes place, they are gene-

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generally of great ſervice when cautiouſly managed, gently ſtimulating and exciting the veſſels into action, which contributes to remove the obſtruction, and taking off that inertia from the ſyſtem in general which is ſo frequently attendant on, and ſo much contributes to increaſe, the complaint. The Bath Waters are likewiſe indicated in caſes, where, in conſequence of the above-mentioned inertia, a ſtagnation of the fluids in particular parts has taken place, as in œdematous complaints, owing to this cauſe, ſuch are frequently called low, weak, phlegmatic caſes. Of this kind are thoſe œdematous ſwellings of the legs, and ſometimes of the body, which we often ſee ſucceeding intermittent, and ſometimes continued fevers, in which the Bath Waters are of ſignal ſervice. The like ſymptom often takes place after a fit of the gout, for the relief of which the Bath Waters are the beſt remedy. In theſe, if tried before the diſeaſe is too far advanced, they are extremely efficacious, by their ſtimulus exciting the exhalent veſſels to contraction, increaſing the action of the abſorbents, and encouraging the fluids to paſs off by the proper ſecretions. I ſhall now proceed to ſpeak of their effects in this way on the nervous ſyſtem. PART IV.

As the Bath Waters are found ſerviceable in exciting the motion of the veſſels when languid, they likewiſe are efficacious in inertia of the nervous ſyſtem. Paralytic diſorders are of this kind, in which the Bath Waters, as ſtimulants, have been found of the greateſt ſervice, and, if judiciouſly managed, may be exhibited ſafely in moſt of the kinds of this complaint. They are peculiarly ſervicable (when drank) in thoſe caſes where the affection ariſes from diſorders of the bowels, as in thoſe ariſing from the bilious cholic, and thoſe which proceed from fumes of metallic ſubſtances, as arſenic, copper, antimony, lead, and mercury, where their effect ſeems to proceed from the action of theſe ſubſtances on thoſe viſcera. They are likewiſe indicated in thoſe paralytic complaints which follow fits of the gout and rheumatiſm.

The waters are likewiſe of great ſervice in thoſe paralytic complaints which occur in weak habits, ſuch as were formerly called

PART IV. called nervous, and often occur, in conſequence of low and watery diet, damp ſituations, new built houſes, and which often happen among thoſe whoſe buſineſs obliges them to remain in water, or moiſt places for a long time together, as waſherwomen, fiſhermen, &c.

Such are the kinds of paralytic complaints, in which the Bath Waters, taken inwardly, ſeem chiefly indicated; but they are, undoubtedly, of great ſervice in many more; and I am well ſatisfied, that in almoſt every kind of palſy whatever, when judiciouſly managed, that they may be employed with advantage.

Connected with paralytic diſorders are the apoplexy, lethargy, and other diſorders of a like kind, in which likewiſe theſe waters are often of eſpecial ſervice.

The apoplexy has been divided by writers into the ſanguineous and ſerous; and ſtimulant medicines have been thought proper in the latter only. I believe there is a foundation for a diſtinction of this kind, yet I am well aſſured that the Bath Waters are of great ſervice in both theſe, in the latter immediately, and in the former after due evacuations; and I make no doubt that theſe waters, though very likely to bring on this diſorder in a plethoric habit, if improperly uſed, may nevertheleſs be of the greateſt ſervice in preventing their acceſs, if judiciouſly managed, and this not only in the ſerous apoplexy, but in the ſanguineous kind alſo, and I think I have ſeen ſigns of their approach obviated by the uſe of them.

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I ſhall next ſpeak of the efficacy of the Bath Waters as ſtimulants, in diſorders of the alimentary canal.

The Bath Waters are of the utmoſt efficacy in all diſorders that depend on the inertia of the organs of digeſtion. This is the ſource of many complaints, ſuch as are generally called of the ſtomach, and aceſcency proceeding from the ſame cauſe, and the food's making too long a ſtay in the body.

In theſe complaints the Bath Waters are generally of great ſervice, eſpecially of of that kind which is produced by hard drinking, in which caſe the Bath Waters often exert a peculiar effect, exciting the ſtomach and bowels to perform their functions, when the ſtrongeſt ſtimulus of other kinds had been uſed without effect. They likewiſe eminently relieve the coſtiveneſs, which ſo often attends a bad digeſtion, by reſtoring and exciting the periſtaltic motion of the bowels to propel the food, and thus prove evacuants by means of their ſtimulus. I ſhall ſpeak more of their action on the ſtomach when I ſpeak of their aſtringent and antiſpaſmodic qualities.

There is likewiſe another kind of languor, or inertia, in which the Bath Waters are of great ſervice, which may be referred to this head; I mean the Gout. The nature of this diſorder has been hitherto very imperfectly explained; but ſo much is certain, that it is peculiarly connected with the ſtomach, a certain ſtrength and tone of which is neceſſary to produce the gout in its proper ſituation, the extremities. The Bath Waters are found, by experience, to be the beſt and ſafeſt medicines for this purpoſe yet known; their ſtimulus on the ſtomach being immediate and peculiar, reſtoring to it ſuch a degree of tone as enables it to ſend the gout into its proper place. On this account the Bath Waters are of the greateſt ſervice in erratic gouty complaints, eſpecially thoſe wherein the gout attacks the noble parts, from an inertia of this organ, produced by exceſs in drinking fermented liquors, and exceed, in this reſpect, any medicine hitherto known.

I ſhall next ſpeak of the caſes wherein the Bath Waters are indicated as *aſtringents.*

They are indicated in this reſpect, in debility and laxity of the moving fibres, as in the rickets, in which caſe they have been often of great ſervice. They are likewiſe indicated in the weakneſs which often ſucceeds large evacuations either of blood, ſtool, or perſpiration, either artifically produced, or owing to nature. This often takes place after feveriſh diſorders, wherein large evacuations, though neceſſary at the time, yet in their conſequences are prejudicial, in exhauſting the vital powers. In reſtoring theſe the Bath Waters are very ſucceſsful, and often prevent dropſical complaints, which ſo often occur in ſuch circumſtances.

PART IV. They are likewiſe equally efficacious in ſuch circumſtances, when occurring in conſequence of weakneſs brought on by large evacuations, whether of blood or perſpiration, in lying-in women.

The Bath Waters are likewiſe indicated as aſtringents in increaſed evacuations depending on laxity of the ſolids, or debility, and conſequent irritability of the moving fibres. Of this kind are frequently the alvine evacuations, where a diarrhœa continues merely, as it ſeems, from an inability in the inteſtines, owing to laxity, to retain the food a ſufficient time in the body. This often takes place after large evacuations of any kind, but principally after violent alvine evacuations, either natural, or procured by medicine. In theſe complaints, when unattended with fever, the Bath Waters are of the utmoſt ſervice, and have often reſtrained fluxes of this kind, when the common aſtringents have been uſed without ſucceſs.

They are likewiſe of great ſervice in habitual laxities not owing to theſe cauſes, but merely produced by a lax, and, poſſibly, on that account irritable, ſyſtem of the in-

inteſtines. In theſe caſes the Bath Waters, by their aſtringent quality, take off the flaccidity, and enable the inteſtines to retain the food, and; by reſtoring their tone, take off the irritability which produces the diſpoſition to frequent evacuations, and thus prove antiſpaſmodic, by means of their aſtringent quality.

The Bath Waters have been likewiſe of great ſervice in reſtraining evacuations by the urinary paſſages, as well as ſtool. They have been found efficacious in the diabetes, when all other medicines had failed, even the ſtrongeſt aſtringents.

They have been no leſs efficacious in reſtraining that diſpoſition to perſpiration, which ſometimes attends people of a lax and irritable habit, and is very weakening, though unaccompanied with a hectic fever.

Bath Waters are likewiſe efficacious by this quality, in reſtraining the fluor albus, and have often cured this obſtinate diſorder in the moſt unpromiſing circumſtances. They generally ſucceed beſt when the conſtitution will bear their ſtimulant as well as aſtringent qualities.

PART IV. From analogy we may conclude, that they are likely to be of ſervice in involuntary ſeminal evacuations.

Another quality which the Bath Waters poſſeſs, of great conſequence, is their *diuretic* one. The free paſſage of the waters, by this excretion, has been generally eſteemed a happy preſage of their effects in moſt complaints. But I am well aſſured that they are peculiarly adapted to ſome caſes by this quality.

Their diuretic power renders them eſpecially ſerviceable in diſorders of the dropſical kind, which are frequently relieved by it, notwithſtanding the apparent impropriety of uſing a medicine that contains ſo large a proportion of watery fluid.

In anaſarcous caſes, when recent, and a good degree of ſtrength remains, they are generally ſucceſsful, and prove the moſt effectual evacuators of the water, at the ſame time as, by their aſtringent quality, they contribute very much to guard againſt a return of the diſorder; nay, inſtances are not wanting where Bath Waters have been found ſucceſsful in the moſt advanced ſtages of this complaint, when large quantities were uſed; and I am almoſt inclined to believe, both from theory and the hiſtory of diſeaſes, that they were more efficacious formerly, when drank in large quantities, than they are at preſent, ſince cuſtom has diminiſhed the quantity in which they are taken *.

They have been found peculiarly ſucceſsful in thoſe dropſical complaints which ariſe from a ſuppreſſion of ſome of the natural evacuations. Of this kind are thoſe which happen from a check of perſpiration, which are frequent among thoſe who have changed their reſidence from a hot to a cold climate, and ſuch are generally relieved by the uſe of Bath Waters. Another caſe of this kind is, when a dropſical complaint comes on in conſequence of the ſtoppage of the menſtrual

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* The numerous cures, by the Bath Waters, of dropſical diſorders, even in their laſt ſtage, induces me ſtrongly to think, with Dr. Heberden, that Phyſicians are in the wrong to reſtrain the drinking largely of diuretic liquors, and that the thirſt, which attends theſe diſorders, ought to be conſidered, as in fevers, an indication of nature towards their cure. It is obſerved of ſeveral diuretic ſubſtances, particularly nitre and cantharides, that they are moſt efficacious as diuretics, when diluted with a large portion of water.

evacuation, and in this too they have been found very efficacious.

They are likewiſe of great ſervice in the ſame complaints, ariſing from an oppoſite cauſe, ſuch as an increaſed evacuation, as by blood, ſtool, or perſpiration, and in thoſe which ſometimes ſucceed fevers, (eſpecially of the intermittent kind) and immoderate diſcharges after delivery, or loſs of ſtrength, by too great diſcharge by perſpiration or purging at theſe times.

I am likewiſe inclined to attribute their effects, in ſome cutaneous diſorders, to this quality. They have been long famous for their effects in leprous complaints, in which diuretics, as hath been obſerved by Dr. Mead, are of great ſervice, and on this quality depends the effect of tincture of cantharides, which is often ſucceſsfully given in this diſeaſe. Their diaphoretic, and, perhaps, antiſeptic qualities, may have ſome effect here, but I imagine the diuretic quality is the moſt material. Theſe waters are likewiſe often ſucceſsfully adminiſtred in ſcrophulous complaints, and it is not, in my opinion, improbable, that their ſucceſs in that diſorder may be owing

ing to their diuretic quality. If acrimony of the fluids be, in any caſe, the cauſe of diſorder, it ſeems as likely to be preſent here as in any; if ſo, the action of the Bath Water, in curing this diſorder, is moſt properly attributed to this quality, ſince, by it, they revacuate the acrimonious particles, which, in general, adhere to the ſeroſity which is paſſed off by urine. Perhaps they may act alſo by their bulk as diluents, abating, by this means, the ſtimulus of the acrimony, and, by their quick paſſage, waſhing out the acrimonious particles from the lymphatic glands, and evacuating them by the urinary ſecretions.

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What makes this account of their mode of operation more probable is, that even common water, largely drank, has been of great ſervice in this diſorder, which could only be owing to its effect in waſhing out the lymphatic ſyſtem. But the Bath Waters are found more efficacious, probably, in ſome meaſure, as they are ſooner evacuated, from their peculiar diuretic quality. They are likewiſe of great ſervice in ſome of thoſe diſorders which are commonly called ſcorbutic, and are attended with ſome ſigns of putreſcency, ſuch as flaccid gums, ſubject to hæmorrhage, looſe teeth, &c. In all probability their diuretic quality is of great uſe here, ſince, by that, they evacuate the ſaline putreſcent part of the blood, and hence diuretics in general are found to be antiſcorbutic.

Probably to this quality likewiſe, may be, in part, referred, their good effects in obſtructions of the liver. The uſe of diuretics in theſe diſorders is well known, but this effect in general is very difficult to be accompliſhed, as the urine is moſt commonly ſecreted in ſmall quantity, and a conſiderable degree of languor and inſenſibility is generally ſpread over the ſyſtem which is difficult to overcome. In theſe caſes the Bath Waters, if tried in the beginning of the diſorder, before any inflammation or confirmed obſtruction has taken place, are generally ſucceſsful, proving the beſt diuretics, and by that means evacuating the ſaline parts of the blood, grown acrimonious by long retention, and, by being mixed with the bile, regurgitated into the courſe of circulation. They likewiſe waſh out their lymphatic ſyſtem of the liver as diluents, and, as ſtimulants, take off that inertia ſo common in bilious complaints. They are likewiſe of great ſervice, by this quality, in ſome gravelly complaints. In thoſe diſorders of this kind, where the ſand is of the red ſort, and, though generated often in great quantity, does not ſeem diſpoſed to concrete, theſe waters, by their diuretic quality, which they exert without any inflammatory ſtimulus on the urinary organs, prove of great ſervice, eſpecially if uſed in the intervals of the paroxyſms.

In theſe caſes they are often of infinite ſervice in diſcharging the gravelly concretions from the kidneys and bladder in large quantity, and with more ſafety than any other diuretic.

The Bath Waters ſeem likewiſe, in many caſes, indicated, on account of their *diaphoretic* quality. Probably their great effect in ſtopping, or moderating habitual laxities of the bowels, may be owing as much to the reſtoring the determination of the fluids to the ſurface, as to their aſtringency; and, in all probability, the ſame quality is of great ſervice in the cure of thoſe ſpontaneous vomitings of the food which we ſee ſo much relieved by theſe waters. Their diaphoretic quality is, undoubtedly, of great conſequence in this caſe, from the great conſent between the ſtomach and bowels and the ſurface of the body. It is generally obſerved in theſe caſes, that the ſkin is dry and parched, and that the reſtoration of perſpiration is the beſt ſign of recovery. Sydenham found, that in violent retchings all medicines were in vain until a degree of perſpiration could be procured; and it is probably owing to the diaphoretic property that ipecacuanha proves ſo ſerviceable in the diarrhœa and dyſentery. Probably, therefore, it is on account of this quality that the Bath Waters are ſo ſerviceable in habitual evacuations of this kind, unattended with fever.

It is not improbable, that the good effects of the Bath Waters in the diabetes, may be in part owing to their changing the tendency of the fluids from the urinary to the perſpiratory ſecretions. The Bath Waters, likewiſe, have been found a powerful remedy for that kind of dropſy which often happens to thoſe who changed ſuddenly a hot for a cold climate, and is, with great probability, attributed to the check given to perſpiration by that means. In hot climates Nature ſeems to have acquired a habit of paſſing off a great part of the excrementitious fluid by means of the ſkin; and when this paſſage is obſtructed, as in this caſe it is, in a great meaſure, by cold, which here conſtringes the pores more than in the caſe of thoſe who have been accuſtomed to the climate, on account of their greater ſenſibility to it, they do not eaſily paſs entirely off by the other paſſages, and, by being thus confined in the body, cauſe dropſy. A dryneſs of the ſkin, and defect of perſpiration, is a general ſymptom of dropſy, and it has been long obſerved, that the reſtoration of perſpiration was a great ſtep towards a cure. This the Bath Waters, if tried before the diſorder is too far advanced, accompliſh very ſucceſsfully, and prove the moſt effectual cure for the dropſy by theſe means. They are, probably, ſerviceable in all dropſies by this quality, but ſeem more particularly adapted (as diaphoretics) to that kind juſt mentioned, PART IV. tioned, which ſeems more evidently to ariſe from an obſtruction of perſpiration.

They are likewiſe found of great ſervice in thoſe cutaneous eruptions which often come on after a ſudden check given to perſpiration, and which generally affect the face, and are frequently produced by a draught of ſome cold liquor taken during a copious perſpiration. This is moſt probably owing to the perſpirable matter accumulated in the glands, and by the ſudden conſtriction induced retained there, and by its ſtagnation growing acrimonious, and irritating the parts ſurrounding.

The face in this diſorder is principally affected, probably from the large perſpiration that generally is produced from it, and likewiſe as it is ſubject, being uncovered, to frequent interruptions of this evacuation by cold.

In theſe caſes the Bath Water proves the ſafeſt and moſt effectual cure, ſince they, by reſtoring the perſpiration, procure an exit for the acrimonious matter; whereas other applications that have this effect produce it as aſtringents, by cauſing it to be abſorbed into the veſſels, where it is productive of the worſt conſequences, generally producing a diſorder of the conſumptive kind.

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Another complaint wherein the Bath Waters are, in my opinion, ſtrongly indicated as diaphoretics, is the *rheumatiſm*; by this I mean that kind, or at leaſt that ſtage of it, which is not attended with any conſiderable degree of fever or inflammation.

To reſtore perſpiration, or at leaſt a certain degree of determination to the ſurface of the body, ſeems obviouſly an indication in many rheumatic caſes, ſince the ſtoppage of it is ſo frequently the evident cauſe of the diſeaſe.

Thus we ſee no complaint ſo frequently induced as this, by damp bedding, ſudden expoſure to cold, blaſts of air on any particular part of the body, &c. and it is found by experience that diaphoretic medicines give the moſt effectual relief, and hence is derived the efficacy of Dover's powder*, and the antimonial preparations.

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* Vide Sydenham, p. 272.

Part IV. Towards the decline of the inflammatory diatheſis the Bath Waters generally are very ſucceſsful, both in alleviating the pain, by promoting a diaphoreſis, and by their ſtrengthening qualities preventing that weakneſs which is ſo apt to remain on the part after an attack of this diſorder. They are likewiſe very uſeful in reſtoring the ſtrength, and thereby enabling the patient to make uſe of his limbs, which is found to be the beſt preventer of that rigidity which is ſo apt to follow fits of this complaint, and ariſes from the diſuſe of the limbs, owing to the difficulty of moving them.

I ſhall now ſpeak a few words concerning the efficacy of the Bath Waters, as given with this intention in the Gout. I have before ſpoken of their power in throwing the gout from the vital parts upon the extremities, when I treated of them as ſtimulants, and I believe their effects in allaying the pain, and carrying off the paroxyſm, as diaphoretics, are not leſs remarkable. They ſecond, in this reſpect, in an admirable manner, the intention of nature, promoting, in a mild and eaſy, but effectual manner, that gentle diaphoreſis mentioned by Sydenham as the moſt favourable method of the paroxyſms going off, and do not, like other evacuants, weaken the body at the ſame time, but, on the contrary, ſtrengthen greatly the vital powers.

Their effect in this way is very great, in giving a full and compleat termination to the paroxyſm, and by that means rendering the intervals more compleat, and the limbs, in conſequence, leſs liable to become rigid, than could be attained by the application of any other medicine.

I ſhall now conſider the Bath Waters relative to their antiſpaſmodic quality.

This property they undoubtedly poſſeſs in a conſiderable degree, though their uſe ſeems more adapted to thoſe caſes which proceed from affections of the viſcera, than where the nervous ſyſtem in general, and ſenſorium commune are primarily affected.

Thus theſe waters are of the greateſt ſervice in hyſteric and hypochondriac complaints, ariſing from a weak ſtomach and digeſtion, and thus prove in their con-

PART IV. ſequence antiſpaſmodic; but they are likewiſe in many caſes directly ſo.

They afford a very immediate relief in the hyſteric colic, which is generally attended with ſpaſmodic affections, and have given the moſt immediate eaſe in bilious vomitings, which are often of the ſpaſmodic kind.

But their moſt remarkable effect in this way is in the colic of Poictiers*, commonly called the dry belly-ach. This diſorder is always attended with a ſpaſmodic conſtriction of the bowels, which are the ſeat of this diſorder. In removing this, the Bath Waters have been much more efficacious than any other remedy, and have often obtained a paſſage through the body, when the ſtrongeſt purgatives, even when mixed with antiſpaſmodics, had been tried without ſucceſs†. This diſorder, from whatever cauſe it ariſes, ſeems particularly ſuited to theſe waters; which, if taken before it be too far advanced, prove an almoſt certain cure*. I am likewiſe inclined to attribute their effects in icterical complaints very much to this quality of them. A jaundice is frequently owing to a ſpaſmodic conſtriction of the biliary ducts, by which the bile is prevented from paſſing into the inteſtines, and regurgitated into the blood. In theſe caſes the Bath Waters often give almoſt immediate relief, relaxing the ſpaſm, and opening a paſſage for the bile, by its proper exit, and thus curing the diſorder. They are likewiſe of the greateſt uſe where the gall ducts are obſtructed by biliary concretions. In this caſe, the duct, though capable of conſiderable dilatation, is frequently ſpaſmodically contracted by the irritation of the biliary calculus, which is detained in its paſſage by that means, and occaſions exquiſite pain in procuring a paſſage. For theſe the Bath Waters are of the greateſt ſervice; and I believe more gall ſtones have been obſerved to be voided during a courſe of the Bath Waters, than

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* For a confirmation of the good effects of Bath Waters in this complaint, vide Medical Tranſactions, vol. ii. p. 81—89. Dr. Warren's paper on the Colica Pictonum.

† The conſtriction of the bowels in this diſorder is not owing, as ſome have thought, to a paralytic affection induced on them, but to a ſpaſmodic conſtriction, which is proved by the relief of this ſymptom by opiates.

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* Curationem abſolunt ſulphure devites, Thermæ omni medicamine præſtantiores. *Tronchin de Colica Pictonum.*

PART IV. any other known medicine. A ſolvent of gall ſtones in the body has been generally, and, I believe, with reaſon, looked on as impracticable, ſince they lie ſo much out of the reach of medicine, as Dr. Heberden has properly obſerved*, and on this account the experiments made on theſe ſubſtances, out of the body, have been juſtly regarded as frivolous and unſatisfactory.

I imagine that an ingenious and learned writer conſidered the Bath Waters in this light, when he repreſented them as uſeleſs in this complaint. For with reſpect to their efficacy in removing the ſymptoms, there can be ſcarce more doubt with any perſon who has had an opportunity of obſerving their effects, than of the Peruvian bark, in removing an intermittent fever. They powerfully promote the paſſage for the bile into the inteſtines, relaxing the duct by their antiſpaſmodic quality, and, by their gently ſtimulating one, promoting the reſorbtion and excretion of the bile, and by waſhing out the lymphatic ſyſtem

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* Vide Medical Tranſactions, vol. ii. on Diſeaſes of the Liver.

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PART IV.

they remove obſtructions of the liver, and thereby prevent many of the ill conſequences that ariſe from thence, ſuch as ſcirrhus, inflammations*, &c.

One great advantage which attends the uſe of the Bath Waters in this complaint is, that they may be uſed in general with great freedom through the courſe of it, provided no ſcirrhus, or actual inflammation of the part, has taken place, ſince there is otherwiſe no danger to be apprehended from their ſtimulus. Dr. Heberden has obſerved, that the pulſe is very often ſcarce quickened by the moſt violent pain excited by the difficulty of paſſing a biliary concretion, and in general the pulſe is below the ſtandard, and of courſe their ſtimulant quality is rather beneficial than injurious.

Hyſteric diſorders, and menſtrual obſtructions, likewiſe, are frequently owing to ſpaſmodic conſtriction of the uterine veſſels. In relieving this complaint, when proceeding from this cauſe, the Bath Wa-

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[*] Magnâ enim copiâ potatæ hæ aquæ (medicatæ ſcilicet) venis bibulis inteſtinorum reſorbtæ cito integris ſuis viribus, pro magna parte, in venam portarum veniunt, & ſic per omnia hepatis loca diſtributæ ſolvunt impacta, & vaſa obſtructa reſerant. VAN SWIETEN, vol. iii. p. 346.

ters are of eſpecial ſervice as antiſpaſmodics, and are very frequently ſucceſsful where they proceed from an increaſed irritability of the nervous ſyſtem.

On this account they are often of great ſervice in thoſe obſtructions which occur at an early period of life, and in hyſteric conſtitutions. Sydenham * adviſes them as the laſt reſort in this diſorder.

In theſe caſes, then, the Bath Waters prove emmenagogue, in conſequence of their antiſcorbutic quality.

The Bath Waters, I imagine, are alſo often of the utmoſt ſetvice in the gout, by means of this property. When this complaint attacks the ſtomach, it frequently appears in form of a ſpaſmodic affection. In this caſe nothing is more efficacious in throwing it back into its proper ſituation than the Bath Waters. Their action in this caſe is too ſudden to be attributed to any other mode of acting than their effect on the nerves of the ſtomach, and that this effect is produced in conſequence of their antiſpaſmodic quality, appears probable,

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* P. 411. Diſſ. Epiſtol.

from the great effect of antiſpaſmodic medicines, particularly muſk, in ſimilar circumſtances.

The laſt quality of the Bath Waters, of which I ſhall ſpeak, is that of being *antiſeptic*. This quality they do not appear to me to poſſeſs in a degree ſufficient to make them particularly indicated on that account; nevertheleſs, I cannot help thinking, that it may in ſome caſes contribute to the cure of ſome diſorders, in which theſe waters are found by experience to be ſerviceable.

Thus it does not ſeem improbable, that the efficacy of theſe waters in cutaneous eruptions, which are frequently attendant on, and often produced by, a ſcorbutic habit of body, may be owing, in ſome degree, to the antiſeptic power of the water correcting the putrid tendency of the humours of the body. This appears to be the caſe alſo in their effects on the body in cachectic complaints, which are frequently attended with this diſpoſition, the change of which is no ſmall ſtep towards the cure of the diſorders. The like appears to take place in many other weak and debilitated caſes, which theſe waters ſo eminently relieve.

CIRCUMSTANCES *in which the* BATH WATERS *are contraindicated.*

PART IV. Having thus ſpoken briefly of the general circumſtances in which theſe waters are indicated; I ſhall now ſubjoin a few obſervations on thoſe caſes in which they are contraindicated; and firſt of them as ſtimulants, as being that quality of them which is the moſt obvious and remarkable.

As theſe waters were indicated, in caſes where the motion of the ſyſtem was languid, it follows in general, that where this is preternaturally increaſed, that they muſt be improper. Thus they are, in general, improper in all diſeaſes, owing to, or attended with, an increaſed impetus of the fluids, and in every circumſtance where this diſpoſition prevails.

This is plainly ſhewn in their effects, when imprudently taken, during a cold or feveriſh complaint, the ſymptoms of which they are found greatly to aggravate. In general it may be laid down, that where the pulſe and heat, the laſt eſpecially, exceed the common ſtandard in health in any conſiderable degree, there the uſe of the waters is improper. They are likewiſe injurious in caſes, where, although no inflammatory complaint is actually preſent, yet ſuch a diſpoſition exiſts in the ſyſtem, as is the caſe in phthiſical complaints of the pulmonary kind, wherein the uſe of theſe waters is particularly dangerous. PART IV.

They are likewiſe forbidden in caſes where the motion of the ſyſtem is partially too ſtrong, as in all topical inflammations, wounds, recent gangrenes, &c. which are greatly increaſed by their uſe. This holds true of cancers particularly. The gout, indeed, is an exception to this, becauſe inflammation is the only ſalutary form in which it appears, and the Bath Waters, by increaſing this only, encourage it to go off in the manner intended by Nature.

They are moreover improper in all caſes, where, although no inflammation or inflammatory diſpoſition prevails, yet where the exciting the motion of the ſyſtem would be attended with hazard, as is the caſe in hæmorrhagy[*], in which they

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[*] This holds true of the venereal diſeaſe alſo.

PART IV. are very dangerous, and which they are found to excite very powerfully. They are likewiſe, for the ſame reaſon, to be avoided in plethoric habits, wherein all the veſſels are diſtended with a large quantity of blood, and its return to the heart obſtructed in ſome degree, or rendered more difficult by the preſſure of the fat on the venous ſyſtem. The Bath Waters, when uſed imprudently in caſes of this kind, without ſome previous evacuation, by increaſing the impetus of the fluids, cauſe ruptures of the blood veſſels, in the head eſpecially, and cauſe, in conſequence, lethargy and apoplexy.

They are likewiſe very dangerous on this account, to thoſe who have a diſpoſition to maniacal diſorders, proceeding from, or attended with, inflammation of the brain, or its membranes. The ſtimulus of the Bath Waters, as well as ſpirituous liquors, ſeems to be particularly exerted on the ſenſorium commune, as is evident from the ſimilar effects of both, ſuch as vertigo and giddineſs, and if largely taken, a degree of intoxication. As the uſe of ſpirituous liquors is particularly hazardous in this complaint, it is reaſonable to ſuppoſe that the Bath Waters muſt, in ſuch caſes, be improper or dangerous.

For the ſame reaſon the uſe of the Bath Waters is forbidden in confirmed obſtructions of the abdominal viſcera. When we are certain that any ſuch actually exiſt, this caution is, undoubtedly, proper, as in the caſe of ſcirrhus, in which caſe ſtimulants of all kinds are highly injurious, and tend rather to fix than remove the obſtruction. But I am inclined to think, as well from obſervation as theory, that this caution is too much attended to, and that the Bath Waters, as well as the Bark *, have got a character which they do not deſerve. This prejudice ſeems tolerably well got over, with reſpect to the bark, which is now found to be the beſt method of preventing the obſtruction it was formerly thought to promote; and, I hope, that the ſame will be the caſe with theſe waters, which, I am well ſatisfied, may be given with greater ſafety, and more efficacy, in beginning obſtructions, ſuch as we commonly ſee in cachectic caſes, than the gum

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* Vide Cleghorn's Diſeaſes of Minorca, p. 202.

PART IV. pills, ſoap, aloes, &c. which are generally given, and there are few ſo unexperienced, as not to know how often without ſucceſs.

I am greatly inclined to ſuſpect, that much time is often waſted in attempting to remove obſtructions of this ſort, the very exiſtence of which is very often only imaginary, by means of this kind, previous to beginning a courſe of theſe waters, when the principal and beſt remedy has been witheld, under a notion of its dangerous conſequence.

Indeed, I cannot think that the Bath Waters, in theſe caſes, would be more dangerous than the fætid gums, aloes, &c. whoſe heating qualities are well known, and are not, at the ſame time, corrected by ſo great a diuretic quality as prevails in the Bath Waters, which is obſerved to be the moſt ſalutary evacuation in diſorders of the glandular kind.

I am well ſatisfied, both from reaſon and experience, that the Bath Waters may, with more ſafety and greater efficacy, be exhibited in theſe complaints than mercurial preparations, which are ſo frequently given, and which are well known to be ſo prejudicial in ſcirrhous and cancerous complaints, (which always owe their riſe to glandular obſtructions) and in which their uſe is now very properly laid aſide. The Bath Waters are alſo contraindicated in caſes where the ſolids are very tender and friable, rupturæ proximæ, as it is called, and the fluids very thin and acrid, which ſometimes takes place in a high degree of the ſcurvy.

In theſe caſes all medicines that ſuddenly increaſe the motion and impetus of the fluids in general are prejudicial. We do indeed give ſome kind of ſtimulants with ſucceſs in this complaint, as ſome of the ſiliquoſe plants, ſcurvy graſs, horſe-radiſh, but then they are of ſuch a nature as only to promote ſome particular excretions without extending their effects over the ſyſtem.

In this caſe the miſchievous effects of their ſtimulant quality would more than counteract the qualities whereby they might be ſerviceable in other reſpects.

The Bath Waters likewiſe are ſometimes contraindicated on account of their aſtringent quality. I knew a perſon myſelf, who had a coſtive habit ſo increaſed by

PART IV. their uſe, as to admit of ſcarce any relief while they were continued, and on that account was obliged to leave them off. But in general this ſymptom is eaſily relieved, by proper medicines uſed at the ſame time with them.

I have likewiſe heard of one perſon in whom their diuretic quality was increaſed to ſo great a degree as to prove detrimental; and of another who was injured in like manner, by their increaſing the perſpiratory evacuation. But I am well aſſured that theſe inſtances occur too rarely to form any judgment in what caſes they are contraindicated, merely on account of their too great increaſe of theſe evacuations. Such are the caſes in which I think the Bath Waters contraindicated, or likely to prove peculiarly injurious. I do not pretend to recite all the circumſtances in which they are not likely to ſucceed, but I imagine this will be underſtood in general by ſuch not being mentioned among thoſe in which they are indicated.

I ſhall next ſubjoin, for the uſe of the Faculty principally, a liſt of the ſpecies of diſorders, according to Dr. Cullen's Syſtem, in which the Bath Waters are likely to ſucceed.

SECT. III.

PART IV.

TABLE *of* DISEASES *in which the* BATH WATERS *are likely to be ſerviceable.*

CLASSIS I.

PYREXIÆ.

ORDO I.

PHLEGMASIÆ.

GENUS XXII.

RHEUMATISMUS.

IDIOPATHICÆ.

Rheumatiſmus vulgaris. Sauv. ſpec. 2.

The Bath Waters are very ſerviceable here, both during the paroxyſm and in the intervals *.

——— *arthriticus.* Sauv. ſp. 3.

The Bath Waters are here of great ſervice, and may in general be uſed through all the ſtages of this complaint †.

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* The uſe of thermal waters *drank* is here recommended by Sauvage.

† Sublevatur thermis ſulphur eis internè ſumptis. Sauvage.

PART IV. *Arthritis rheumatica.* Sauv. ſp. 3.

The Bath Waters are of great ſervice here.

Lumbago rheumatica *. Sauv. ſp. 1.

The Bath Waters are well ſuited to the intervals and decline of the inflammatory ſtage of this complaint, but are in general rather too heating to be uſed during the paroxyſm.

Iſchias rheumaticum. Sauv. ſp. 10.

The Bath Waters ſeem well adapted to all the ſtages of this complaint.

Iſchias ſanguineum. Sauv. ſp. 2.

This ſpecies is well adapted to a trial of the Bath Waters.

Pleurodyne rheumatica. Sauv. ſp. 3.

This ſeems tolerably adapted to the Bath Waters.

SYMPTOMATICÆ.

Rheumatiſmus ſcorbuticus. Sauv. ſp. 3.

I ſhould think the Bath Waters more likely to relieve this ſymptom, than the mercurial courſe adviſed by Sauvage and Dr. Lind. I am confident they might be tried more ſafely.

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* Intus thermæ ſulphureæ proſunt. Sauvage.

Lumbago ſcorbutica. Sauv. ſp. 11.

This ſeems of a ſimilar nature with the foregoing, and well adapted to a trial of the Bath Waters.

*Rheumatiſmus calidus**. Sauv. ſp. 5.

This ſpecies is well adapted to the Bath Waters.

Rheumatiſmus metallicus. Sauv. ſp. 10.

This ſymptom is much relieved by the Bath Waters.

GENUS XXII.

ARTHRITIS.

SOCIETY

ARTHRITIDIS VARIETATES.

1. PRO TEMPORE ANNI.

Arthritis hyemalis. Sauv. var. 2.
——— *æſtiva.* Sauv. var. 4.

In both theſe the Bath Waters are exceedingly uſeful.

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* Sulphureous waters taken inwardly are here adviſed by Sauvage.

2. PRO CAUSA REMOTA.

Arthritis rheumatica. Sauv. ſp. 3.

The Bath Waters are likely to be of great uſe here.

——— *rachialgica.* Sauv. var. 11.

The Bath Waters are of great ſervice in removing or allaying this ſymptom*.

3. VARIAT. COMPLICATA.

Arthritis chlorotica. Sauv. var. 5.

Bath Waters are of great ſervice here.

——— *melancholica.* Sauv. var. 6.

——— *ſcorbutica.* Sauv. var. 7.

In both theſe Bath Waters are likely to be of great ſervice.

Arthritis aſthmatica. Sauv. var. 9.

I ſhould think the Bath Waters likely to ſucceed here.

GENUS XXXVIII.

MENORRHAGIA.

2. SEROSA.

Leucorrhœa. Sauv.

In caſes of this kind proceeding from laxity without any local affection, the Bath Waters are frequently ſucceſsful.

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* Aquæ thermales ſulphureæ ſuadentur. Sauvage.

ORDO V.

PROFLUVIA.

GENUS XXXIX.

DYSENTERIA.

2. SYMPTOMATICÆ.

Dyſenteria ſcorbutica [*]. Sauv. ſp. 18.

The Bath Waters ſeem likely to be of great ſervice here.

CLASSIS II.

NEUROSES.

ORDO I.

COMATA.

GENUS XL.

APOPLEXIA.

IDIOPATHICÆ.

1. CAUSIS INTERNIS.

Apoplexia pituitoſa. Sauv. ſp. 7.

Bath Waters are often of great ſervice in removing the effects of this diſorder[*].

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[*] Sauvage adviſes here the uſe of ſulphureous waters.

[†] Thermal waters are recommended by Sauvage for the ſame purpoſe.

PART IV. *Lethargus literatorum.* Sauv. ſp. 7.

The Bath Waters promiſe to be of great ſervice here.

GENUS XLI.
PARALYSIS.

1. IDIOPATHICÆ.

Hemiplegia ex Apoplexia. Sauv. ſp. 7.

In this the Bath Waters are often very ſerviceable.

Paralyſis ſeroſa. Sauv. ſp. 12.

The Bath Waters are here very proper.

Hemiplegia ſaturnina. Sauv. ſp. 14.

The Bath Waters are here of the utmoſt ſervice.

Paralyſis metallariorum. Sauv. ſp. 22.
Tremor metallurgorum. Sauv. ſp. 5.

In both theſe, which ſeem to be near a-kin, the Bath Waters are frequently of great ſervice.

II. SYMPTOMATICÆ.

Paralyſis rheumatica [*]. Sauv. ſp. 3.

The Bath Waters are of great ſervice here.

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[*] Sauvage adviſes ſulphureous waters here.

Para-

PART IV.

Paralyſis rachialgica. Sauv. ſp. 2.

The Bath Waters are of ſignal uſe here, eſpecially if proceeding from lead.

Paraplegia rachialgica. Sauv. ſp. 5.

I doubt not that the Bath Waters would be of great ſervice in this ſpecies, as well as the foregoing.

Paralyſis bilioſa. Sauv. ſp. 9.

After proper evacuations the Bath Waters are of great ſervice in this complaint.

Paralyſis ſcrophuloſa. Sauv. ſp. 5.
——— *ſcorbutica.* Sauv. ſp. 6.

I ſhould think the Bath Waters likely to ſucceed here.

Hemiplegia ſcrophuloſa. Sauv. ſp. 4.

This ſeems a-kin to the foregoing, and proper for a trial of the Bath Waters.

ORDO II.

ADYNAMIÆ.

GENUS XLIII.

DYSPEPSIA.

PART IV.

I. IDIOPATHICÆ.

Cardialgia bradypepta. Sauv. ſp. 9.

The Bath Waters are of great ſervice in this ſpecies when owing to weakneſs, proceeding from fevers, living on a moiſt and cool diet, or the abuſe of fermented liquors. When native or hereditary, the Bath Waters often fail.

Anorexia pituitoſa. Sauv. ſp. 2.

I ſhould think the Bath Waters likely to be of great ſervice here.

Vomitus pituitoſus. Sauv. ſp. 26.

I ſhould think this ſpecies ſuited to the Bath Waters.

Nauſea ex cacochylia. Sauv. ſp. 11.

I ſhould think this likely to be relieved by Bath Waters.

Cardialgia flatulenta. Sauv. ſp. 3.

Very proper for a trial of the Bath Water.

Gaſtrodynia flatulenta. Sauv. ſp. 2.

This is well ſuited to the Bath Waters likewiſe.

Flatulentia acida. Sauv. ſp. 1.
——— *nidoroſa.* Sauv. ſp. 2.

Both theſe are adapted to the Bath Waters.

Anorexia paralytica. Sauv. ſp. 1.

When this proceeds from the inordinate uſe of fermented liquors, the Bath Waters are very proper.

Gaſtrodynia atterens. Sauv. ſp. 10.

I ſhould imagine the Bath Waters likely to be ſerviceable.

II. SYMTOMATICÆ.

1. A MORBO IPSIUS VENTRICULI.

Anorexia bilioſa. Sauv. ſp. 6.

This ſpecies is undoubtedly ſuited to the Bath Waters.

Gaſtrodynia bilioſa. Sauv. ſp. 3.

This ſpecies appears to be well ſuited to a trial of the Bath Waters.

PART IV.

2. A MORBO ALIARUM PARTIUM VEL TOTIUS CORPORIS.

Vomitus ab hepate obſtructo. Sauv. ſp. 16.

This is very likely to be relieved by the Bath Waters *.

Gaſtrodynia hypochondriaca. Sauv. ſp. 16.

I ſhould imagine this ſuited to the Bath Waters.

Gaſtrodynia chlorotica. Sauv. ſp. 15.

This is certainly ſuited to the uſe of the Bath Waters.

Anorexia arthritica. Sauv. ſp. 12.

This ſymptom is much relieved by the Bath Waters.

GENUS XLIV.

HYPOCHONDRIASIS.

1. IDIOPATHICÆ.

Hypochondriaſis melancholica. Sauv. ſp. 3.

Bath Waters may certainly be often of great ſervice here.

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* Sauvage adviſes the uſe of thermal waters in this complaint.

Hypochondriaſis pituitoſa. Sauv. ſp. 4. PART IV.

This is certainly ſuited to a trial of Bath Waters*.

2. SYMPTOMATICÆ.

Hypochondriaſis hyſterica. Sauv. ſp. 5.

This ſeems adapted to the Bath Waters.

GENUS XLV.

CHLOROSIS.

1. VERÆ.

Chloroſis virginea. Sauv. ſp. 1.

This ſeems well ſuited to the Bath Waters.

1. SPURIÆ, ſeu PALLORES.

Chloroſis rachialgica. Sauv. ſp. 12.

This ſeems likely to be relieved by Bath Waters.

ORDO III.

SPASMI.

SECT. I.

IN FUNCTIONIBUS NATURALIBUS.

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* Sauvage adviſes the uſe of ſulphureous waters.

GENUS XLVI.

TETANUS.

1. IDIOPATHICÆ.

Tetanus tonicus. Sauv. ſp. 1.
——— *emproſthonicus.* Sauv. ſp. 2.
——— *opiſthotonicus.* Sauv. 3.
——— *holotonicus.* Sauv. ſp. 4.

Theſe diſorders ſeldom appear here, but from the account of them I ſhould think them likely to be relieved by the Bath Waters.

GENUS XLVIII.

CONVULSIO.

IDIOPATHICÆ.

Scelotyrbe chorea viti. Sauv. ſp. 1.

This I have ſeen relieved by the Bath Waters.

GENUS L.

EPILEPSIA.

2. SYMPTOMATICÆ.

Epilepſia cachectica. Sauv. ſp. 2.
——— *ſtomachica.* Sauv. ſp. 3.

Both theſe are proper for a trial of the Bath Waters.

Epilepſia uterina. Sauv. ſp. 4.

PART IV.

This is alſo adapted for a trial of the Bath Waters, eſpecially when proceeding from a retention of the menſtrual evacuation.

GENUS LII.

ASTHMA.

1. IDIOPATHICÆ.

Aſthma humidum. Sauv. ſp. 1.

The Bath Waters are often of great uſe in the intervals of the paroxyſms in preventing their return*.

Aſthma ſtomachicum. Sauv. ſp. 8.

This is near a-kin to the foregoing, and likely to be relieved by the Bath Waters.

Aſthma hypochondriacum. Sauv. ſp. 4.

This ſeems likely to be relieved by Bath Waters†.

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* The Bath Waters are eſpecially mentioned by Mr. Sauvage as ſometimes of ſervice in the intervals of this diſorder.

† Thermal waters are adviſed here by Sauvage.

2. SYMPTOMATICÆ.

Aſthma arthriticum. Sauv. ſp. 5.

Bath Waters relieve this ſymptom often very remarkably*.

GENUS LV.

COLICA.

Colica flatulenta. Sauv. ſp. 1.

—— *ſpaſmodica.* Sauv. ſp. 7.

After due evacuations the Bath Waters are of great ſervice in both the abovementioned diſorders.

Rachialgia pictonum. Sauv. ſp. 3.

The Bath Waters are here the beſt remedy, eſpecially if the diſorder be connected with the jaundice.

Rachialgia metallica. Sauv. ſp. 3.

This is very well adapted to the Bath Waters, eſpecially if it be owing to the effects of lead or mercury.

Rachialgia arthritica. Sauv. ſp. 4.

———— *ſcorbutica.* Sauv. ſp. 6.

In both theſe the Bath Waters are likely to be very ſerviceable.

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* Sauvage adviſes the uſe of hot ſprings here.

GENUS LVI.

CHOLERA.

Cholera arthritica. Sauv. ſp. 10.

In this the Bath Waters are the beſt remedy.

GENUS LVII.

DIARRHOEA.

1. IDIOPATHICÆ.

Diarrhœa vulgaris. Sauv. ſp. 2.

This may be proper for a trial of the Bath Waters.

Diarrhœa ab hypercatharſi. Sauv. ſp. 16.

This is frequently cured by the Bath Waters.

Diarrhœa arthritica. Sauv. ſp. 9.

Bath Waters are the beſt remedy here.

GENUS LVIII.

DIABETES.

1. IDIOPATHICÆ.

Diabetes a vino. Sauv. ſp. 5.

This is often much relieved by the Bath Waters.

PART IV.

2. SYMPTOMATICÆ.

Diabetes hyſtericus. Sauv. ſp. 3.

I ſhould think the Bath Waters likely to be of ſervice here.

Diabetes arthriticus. Sauv. ſp. 6.

Bath Waters often relieve this ſymptom.

GENUS LIX.

HYSTERIA.

1. IDIOPATHICÆ.

Hyſteria chlorotica. Sauv. ſp. 2.

Bath Waters are extremely proper in this ſpecies, eſpecially when accompanied with a retention of the menſtrual diſcharge*.

Hyſteria a menorrhagia. Sauv. ſp. 3.

Bath Waters muſt certainly be proper here.

Hyſteria a leucorrhœa. Sauv. ſp. 4.

Bath Waters are proper here.

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* Warm ſulphureous waters are adviſed by Sauvage to be drank for this complaint.

PART IV.

1. SYMPTOMATICÆ.

Hyſteria ſtomachica. Sauv. ſp. 7.

The Bath Waters, cautiouſly uſed, may be here of great ſervice.

Hyſteria emphractica. Sauv. ſp. 5.

In this the Bath Waters are eminently ſerviceable.

CLASSIS III.

CACHEXIÆ.

ORDO I.

MARCORES.

GENUS LXVI.

ATROPHIA.

Atrophia nervoſa. Sauv. ſp. 1.

The Bath Waters, when uſed in the beginning of this complaint, are of great ſervice.

Atrophia ab alvi fluxu. Sauv. ſp. 6.

The Bath Waters, if uſed before the bowels are excoriated, or much irritated, are of great uſe.

Atrophia a leucorrhœa. Sauv. ſp. 4.

The Bath Waters are very proper here.

PART IV.

ORDO II.

INTUMESCENTIÆ.

SECT. II.

FLATUOSÆ.

GENUS LXVIII.

PNEUMATOSIS.

Emphyſema ſpontaneum. Sauv. ſp. 1.

This is often relieved much by Bath Waters.

Pneumatoſis hyſterica. Sauv. ſp. 3.

The Bath Waters are likely to be ſerviceable here.

GENUS LXIX.

TYMPANITES.

Tympanites inteſtinalis. Sauv. ſp. 1.

Bath Waters are of the greateſt ſervice here*.

Tympanites enterophyſodes. Sauv. ſp. 2.

Much of the ſame nature with the foregoing, and probably adapted for a trial of the Bath Waters.

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* Thermal waters are recommended by Sauvage.

SECT. III.

PART IV.

AQUOSÆ, ſive HYDROPES.

GENUS LXXI.

ANASARCA.

Phlegmatia vulgaris. Sauv. ſp. 1.

The Bath Waters are undoubtedly of the greateſt ſervice here, if uſed early in the complaint.

Anaſarca a fluxu. Sauv. ſp. 2.

Bath Waters are here particularly ſerviceable.

Anaſarca a febribus. Sauv. ſp. 4.

This is generally much relieved by the Bath Waters.

Anaſarca metaſtatica. Sauv. ſp. 1.

In both the varieties of this ſpecies, viz. the periodica and ab adiapneuſtiâ, the Bath Waters are likely to be of great ſervice.

Phlegmatia a menoſtaſiâ. Sauv. ſp. 5.

Bath Waters are here very uſeful.

Anaſarca rachialgica. Sauv. ſp. 8.

This is relieved by the Bath Waters.

GENUS LXXV.

ASCITES.

1. SEROSI ABDOMINALES.

Aſcites ab oppilatione. Sauv. ſp. 2.
——— *ab hepate.* Sauv. ſp. 3.
——— *a liene.* Sauv. ſp. 4.

The Bath Waters are of infinite ſervice in all theſe, provided the diſorder be recent, and no actual inflammation be preſent, or ſcirrhus formed.

Aſcites a ſanguifluxibus. Sauv. ſp. 7.

The Bath Waters are of great ſervice here, provided there be no danger of inducing a freſh hæmorrhage.

Aſcites febrilis. Sauv. ſp. 12.
a. —— *ex quartanâ.*

Bath Waters have been very ſerviceable in caſes of this kind.

Aſcites arthriticus. Sauv. ſp. 9.

The Bath Waters are very proper here.

Aſcites ſcorbuticus. Sauv. ſp. 11.

Bath Waters are of great uſe here.

GENUS LXXIX.

RACHITIS.

Rachitis Britannica. Sauv. ſp. 2.

Bath Waters may be uſed with great advantage in many inſtances of diſorders of this kind.

ORDO III.

IMPETIGINES.

GENUS LXXX.

SCROPHULA.

Scrophula vulgaris. Sauv. ſp. 1.

The Bath Waters have been found of great ſervice in this complaint, when uſed before it be too far advanced.

GENUS LXXXIII.

ELEPHANTIASIS.

Elephantiaſis legitima. Sauv. ſp. 2.

I ſhould imagine the Bath Waters likely to ſucceed here.

GENUS LXXXIV.

LEPRA.

Lepra Græcorum. Sauv. ſp. 1.

——— *Indica.* Sauv. ſp. 3.

In both theſe the Bath Waters are extremely ſerviceable.

GENUS LXXXVII.

ICTERUS.

Aurigo rachialgica. Sauv. ſp. 14.

This ſymptom is certainly proper for a trial of the Bath Waters.

Aurigo ab obſtructione. Sauv. ſp. 6.

When no inflammation or fever, or pain of the liver, is preſent, the Bath Waters are the beſt remedy*.

Aurigo accidentalis. Sauv. ſp. 2.

Bath Waters prove here the quickeſt remedy.

CLASSIS IV.

LOCALES.

ORDO II.

DYSCINESIÆ.

GENUS CI.

CONTRACTURA.

I ſhould imagine the Bath Waters likely to be of ſervice in the ſpecies of this genus.

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* Sauvage adviſes thermal waters.

ORDO IV.

EPISCHESES.

GENUS CVII.

OBSTIPATIO.

Part IV.

When this proceeds from weakneſs, or want of ſenſibility in the bowels, the Bath Waters give great relief.

CHAPTER II.

Part IV.

HAVING finiſhed what I had to ſay on the medical qualities of the Bath Waters, I now proceed to the ſecond Chapter of this Part, which I propoſe ſhall comprehend my ſentiments on the methods by which the waters may be beſt managed, ſo as to fulfil, moſt ſucceſsfully, the above-mentioned indications in the cure of diſeaſes. This, which, in ſome reſpects, may be called the Pharmaceutical Part, I intend to purſue in the order cited at the beginning of the foregoing Chapter. The firſt conſideration that here occurs is relative

1. To our Choice of the Waters.

I have before mentioned the Bath Waters in general, as poſſeſſing the qualities of ſtimulant, aſtringent, diuretic, diaphoretic, antiſpaſmodic, and antiſeptic.

That the qualities of ſtimulant, aſtringent, and antiſeptic, were poſſeſſed in the higheſt degree by the King's Bath Water, thoſe of antiſpaſmodic and diaphoretic by the Hot Bath, and that of diuretic (though of this I am not certain) by the Croſs Bath Water.

In conſequence of this it appears, that where the ſtimulant, aſtringent, or antiſeptic qualities of the waters are deſired to exert their effects, that there the King's Bath Water muſt be moſt adviſeable; where ſuch a degree of ſtimulus or aſtringency would be injurious or improper, and the diaphoretic and antiſpaſmodic effects were more peculiarly to be promoted, there the Hot Bath Waters would be more efficacious; and where a ſtill leſs degree of ſtimulus was proper, and a large quantity of fluid adviſeable to be taken in, and the urinary evacuation more particularly promoted, there the Croſs Bath might be preferable to either of the others.

The particular diſorders for which each water is peculiarly adapted, will be found under the reſpective articles of their qualities, in the former Chapter of this part of the work.

Thus, in general, all the diſorders to which the ſtimulant, aſtringent, and antiſeptic qualities of the waters are there mentioned, as conducive to their cure, will be moſt proper for a trial of the King's Bath Water: Thoſe for which their diaphoretic and antiſpaſmodic qualities are recommended will more properly make uſe of the Hot Bath Water: And where large dilution is required, as in ſome glandular caſes, and the urinary ſecretion to be promoted, there the Croſs Bath would be moſt adviſeable.

But I would have it here underſtood, that I am far from meaning to aſſert, that any directions of this kind ſhould be indiſcriminately obſerved. Though I believe the effects of the Bath Waters on the generality of conſtitutions to be as I have deſcribed them, I am, at the ſame time, fully ſatisfied, that theſe effects are very much varied by cuſtom and peculiarity of conſtitu-

PART IV. conſtitution, and, probably, other cauſes with which we are unacquainted. I have ſeen ſeveral inſtances where the Hot Bath proved more ſtimulant than the King's, and I have been informed, from good authority, that it is not very uncommon for the Croſs Bath Water to prove more heating than either of the others.

Theſe circumſtances point out an uſeful maxim in practice, not to determine precipitately in many diſorders, (whoſe ſymptoms do not immediately forbid their uſe altogether) that the Bath Waters will be of no ſervice, until we have given each of the ſprings a fair trial, ſince they frequently have their effects ſo much varied in peculiar habits and conſtitutions.

The next queſtion that occurs in order, is relative to

2. The ſtate in which the waters, when drank, poſſeſs their medicinal qualities in the greateſt degree.

When we conſider the nature of the ſubſtances with which theſe waters are impregnated, there can remain little doubt with regard to the determination of this queſtion. The fixible air, which perhaps is the moſt important ſubſtance that enters into its compoſition, is of ſo fugitive a nature, as to be in a great meaſure diſſipated ſoon after its expoſure to the atmoſphere. The chalybeate impregnation, likewiſe, whether from its peculiar nature and qualities, or ſlightneſs, is very ſoon deſtroyed, the water giving ſcarce any ſigns of it, except examined ſoon after its riſe. In all caſes, therefore, where the effects of the water, particularly the ſtimulant and aſtringent, are deſired in their full extent, the waters are, undoubtedly, in greateſt perfection drank at the fountain head. Many caſes, however, may be ſuppoſed, wherein the uſe of the waters may be in ſome reſpects adviſeable, yet their ſtimulant qualities may prove too violent a ſhock for a tender frame to endure. In ſuch caſes, by ſuffering it to ſtand a minute or two after it has been drawn, the ſubſtance on which this quality principally depends will be in a great meaſure diſſipated, and their ſtimulus much abated.

It is probable, that their good effects in leprous and other cutaneous diſorders, do not depend ſo much on the ſtimulant, as on the diaphoretic and diuretic qualities, which are more permanent. In theſe caſes, then, it might be adviſeable not to drink the waters at the pump, but more at leiſure, in private, when their heat, on which their ſtimulus in ſome degree depends, was abated. By this means we might be enabled to take them in much larger quantity than we otherwiſe could, a circumſtance of great moment in theſe diſorders, where large dilution, and as it were waſhing out the lymphatic ſyſtem, is of ſo much conſequence. Care ſhould be taken, nevertheleſs, that the water ſhould not be ſuffered to ſtand ſo long as to cauſe any precipitation, as this would altogether alter its nature. In all caſes, however, where the Bath Waters are meant to act as reſtoratives, and of conſequence their ſtimulus, in ſome degree at leaſt, muſt be of ſervice, I would always adviſe them to be drank freſh at the ſpring, and to moderate their effects, if too powerful, rather by leſſening the quantity, than uſing them when deprived of ſome of their ſerviceable qualities.

The ſubject now before us naturally leads to another queſtion, viz. How theſe waters bear tranſportation, or, in other words, what alteration of their qualities is produced by ſtanding. In order to explain this more effectually, it will be neceſſary to make a ſhort recapitulation of the phænomena that appear in theſe circumſtances.

It appears by Experiments, that the Bath Water newly pumped emits a large quantity of air bubbles, which are plentifully evolved from every part of it, and that this impregnation is ſo volatile, that it can ſcarcely be carried any diſtance without loſing, in a great degree, that ſparkling appearance and pungent taſte ſo remarkable in it when freſh. Its chalybeate taſte and qualities are then much diminiſhed, and on remaining a little time expoſed to the air entirely ceaſe.

On cooling, the ſaline taſte, and that of the hep. ſulph. cum calce viva, become much more remarkable, and, indeed, ſome alteration ſeems to take place in the laſt mentioned impregnation, as the water then gives a green tinge to the vegetable blues. If expoſed to the air it ſoon aſſumes a wheyiſh turbid appearance, and lets fall a light aſh-coloured precipitate; and the latter happens in ſome degree even in cloſe veſſels, though the change of colour is not ſo remarkable. From theſe appearances I am induced to believe, that the common opinion that the Bath Water loſes moſt of its valuable qualities on ſtanding, is not ill founded.

The fixed air and chalybeate impregnations are, undoubtedly, deſtroyed, and the hep. ſulph. c. calce viva ſeems to undergo a decompoſition of its parts. A circumſtance happens here that is far from being common in waters of this kind. Moſt of thoſe that contain fixed air, along with a chalybeate impregnation, bear tranſportation very well, and, when carefully cloſed up at the ſpring, may be carried to any diſtance, with ſcarce any diminution of their valuable qualities. The Bath Waters, however, which contain both theſe impregnations, and the former of them in very large proportion, although the bottles containing it be cloſed up with the greateſt accuracy, as ſoon as filled from the ſpring, on their being again opened, give very little marks of the chalybeate impregnation,

tion, and ſcarce any of the aërial one. This alteration ſeems remarkable, as we cannot ſuppoſe it poſſible for the fixed air to have eſcaped, eſpecially as we ſee it retained in like circumſtances in many other waters. The cauſe of this, however, ſeems as if it might be explained as follows:

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All the preparations by which ſulphur is rendered miſcible with water, both by means of an alcali and quick lime, are, in ſome degree, decompoſed on ſuch admixture, and the latter more eaſily than the former. As we have the utmoſt reaſon to believe that the laſt mentioned combination makes a part of the impregnation of the Bath Waters, it is probable that ſuch a decompoſition takes place here, the quick lime and the ſulphur ſeparating from one another. In that caſe the quick lime, whoſe ſtrong affinity with fixed air has been before taken notice of, being now at liberty, attracts that contained in the water, and is thus rendered ſoluble, and makes part of the precipitation obſerved to be formed in the Bath Water on ſtanding. This accounts for the ſparkling appearance and pungent taſte not being obſerved in the bottles containing the water being again opened, as the mephitic air is then in a fixed ſtate, and ſtrongly united with the lime. By this it ſhould ſeem, that the Bath Waters can ſerve very few uſeful purpoſes in medicine, when uſed at a diſtance from the ſpring, their impregnation with fixed air being thus deſtroyed, and the chalybeate and ſulphureous ones nearly ſo. Some ſmall impregnation of the laſt mentioned kind may indeed remain, as even mild calcareous earths render ſulphur in ſome degree miſcible with water, but then this proportion of it is extremely ſmall.

I can, therefore, ſay very little in recommendation of their uſe at a diſtance from the ſpring, as they ſeem to be then little more than ſimple water impregnated with a large portion of ſelenites, and a ſmall one of common ſalt, which certainly are not impregnations likely to ſerve many uſeful purpoſes in medicine.

The next conſideration that occurs is relative to the

3. Quantity in which the Bath Waters ought to be taken.

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Nothing can be laid down with preciſion relative to this point, as it is obvious that it muſt vary greatly according to circumſtances. Our firſt and principal direction, in this caſe, muſt be drawn from the indication we deſire to promote, though the age, conſtitution, time of the year, and peculiarity of diſpoſition of the patient, and the ſtate in which the water itſelf is drank, and our choice of it, the laſt eſpecially, muſt be likewiſe conſidered.

By the old accounts it appears, that theſe waters were taken formerly in much larger quantity than is ever ventured on in the preſent practice. *Guidott mentions three pints a day, as the ſmalleſt quantity commonly taken, and goes ſo far as to recommend, in ſome caſes, even ten pints a day to be ſwallowed. But ſince his time, and of late years eſpecially, the doſe has been much diminiſhed, and the quantity which he adviſed as the ſmalleſt, is now ſcarce ever exceeded, by advice of the Phyſician, even in thoſe caſes where the greateſt quantity is thought neceſſary.

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* P. 265, 266.

I am apt to think, that if the old practitioners have been miſtaken in adviſing them in ſo large quantity, that the moderns, on the other hand, have ſometimes diſappointed their effects, by too great limitation, as I am well ſatisfied that the waters may, with the utmoſt ſafety, in general, be taken in conſiderably larger quantities than thoſe commonly exhibited at preſent.

I believe the modern practice ſcarce ever exceeds three pints in twenty-four hours, and in general half, or at moſt two-thirds of that quantity, are judged ſufficient. To me it appears, that in caſes wherein the ſtimulant or aſtringent qualities of the waters were deſired, and where the Hot or King's Bath Waters, the laſt eſpecially, were recommended, and drank immediately after being drawn there, a moderate quantity would be proper, as their ſtimulus would then exert its full force, and be as much concentrated as poſſible, which muſt limit conſiderably the quantity taken in. Theſe reaſons will hold ſtronger if the patient be young, or of an irritable habit or conſtitution, or make a trial of the waters at a time of year favourable to inflammatory complaints. Add to this, that a large bulk of any medicine is peculiarly diſagreeable to thoſe whoſe ſtomachs have their tone injured, as is the caſe with many who apply to theſe waters for relief.

I have before mentioned, that it is not poſſible to lay down any rule for this that will not be liable to many exceptions, but in general I ſhould think*, that the waters, when exhibited in theſe intentions, might be properly taken, by a grown-up perſon, from two-thirds of a pint to two pints in a day, but not to exceed the laſt mentioned quantity.

In caſes where the diuretic, diaphoretic, or antiſpaſmodic qualities of the waters are deſired, or where the patient is advanced in life, of an inert habit, and makes uſe of them at a moderate ſeaſon of the year, eſpecially if the Croſs Bath, or even the Hot Bath Water be uſed, ſome more latitude may be allowed; though I confeſs, in this caſe, I would not adviſe to go beyond from one pint to two pints and a half, or three pints in twenty-four hours. But in caſes where the waters are uſed as di-

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* I here mean the Hot or King's Bath Water, the laſt eſpecially, as generally given with this intention.

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It is likewiſe an uſeful caution, even in many caſes where their ſtimulus, in ſome degree, is deſireable, but where their inflammatory effects are apprehended, to divide the quantity to be taken in a day into a number of ſmall doſes, to be taken at moderate intervals, by which their ſtimulus becomes leſs ſenſible and more permanent.

This is found to be the caſe, even though the quantity taken in this manner ſhould, on the whole, exceed the other. Thus one pint drank at once has more effect in raiſing the pulſe, and heating the body, than three half pints drank with an hour's interval between each.

The next circumſtance of which I ſhall ſpeak is concerning the

4. Time of the day at which the waters are moſt properly exhibited.

On

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On this I have little new or particular to offer. The general cuſtom has hitherto been, to drink the whole of the water adviſed to be taken before dinner, viz. two-thirds of it before breakfaſt, between the hours of eight and ten, and one-third at noon. I am inclined alſo to believe that the above method is very proper on many accounts, eſpecially when the waters are uſed as ſtimulants, antiſpaſmodics, aſtringents, or diuretics. By being thus taken a moderate time before meals they excite appetite, and promote the digeſtion of food very powerfully. Some are adviſed to repeat them again in the interval between dinner and ſupper, but except a very moderate dinner has been taken, I do not approve much of this method in general. But as the effects of the waters vary ſo much from peculiarity of habit, I will not deny, that in ſome caſes of this kind they may be employed in this way with advantage. I have likewiſe ſeen exceeding good effects from a glaſs of the water drank at going to bed, and I think it always adviſeable to make a trial of them in this manner, when we are particularly deſirous of promoting the diaphoretic ſecretion. A glaſs of the water drank at going to bed is likewiſe often very efficacious in promoting ſleep, which it ſeems to induce by its antiſpaſmodic quality. When the Hot or Croſs Baths are uſed as diluents, as in glandular caſes, and drank at home, or after the ſtimulant qualities of the water have in ſome degree abated, cautions of this kind are leſs neceſſary, and the water may be taken in ſuch manner as ſhall be found by experience moſt agreeable and convenient.

The next queſtion that occurs is,

5. What ſeaſon of the year is beſt adapted to their uſe?

Formerly the uſe of the Bath Waters was confined almoſt altogether to the ſummer months, but ſince that time the colder ſeaſons have been preferred, though extremes of both kinds have always, I believe, been reckoned in ſome degree to contraindicate their uſe. I confeſs it to be my opinion, that we are in general more likely to find their good effects in a warm, than a cool ſeaſon, eſpecially in caſes where their ſtimulant and diaphoretic qualities are likely to be ſerviceable. Thus I have obſerved paralytic caſes more relieved by their uſe, during a ſhort courſe of warm weather, than by a much longer trial of them during a cold ſeaſon. Indeed, in many caſes of this kind, the weather can ſcarce be ſo hot as to render it neceſſary to forbid their uſe, except we actually obſerve ſome inconvenience attending it. The ſame is true, in ſome degree, when we uſe them as diaphoretics, to reſtore the perſpiratory diſcharge, as in many caſes where this diſcharge is interrupted, on changing from a warm to a cold climate, and dropſy and obſtructions of the viſcera are conſequent thereon. In caſes where the Bath Waters are meant to act as reſtoratives in debilitated habits, in which their aſtringent and antiſpaſmodic effects, joined to a moderate degree of ſtimulus, would be deſirable, a more moderate ſeaſon would be adviſeable, as they would not then be either ſo apt to heat by their ſtimulus, or weaken by increaſe of the ſecretions. A priori, we might perhaps imagine that their diuretic qualities would be greateſt in cold weather; but I find the contrary, by experience. A ſeaſon rather cool than warm to the ſenſes, undoubtedly tends to

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promote the paſſage of the waters in this manner; but I find, that when the temperature of the air falls ſo low as to thirty-two degrees, that this quality becomes much more uncertain than in more moderate ſeaſons. I think I have ſeen the Bath Waters in * very cold weather prove cathartic from that cauſe. In general, my opinion is, that the Bath Waters, when deſired to act as ſtimulant, as in low weak caſes, eſpecially of the paralytic kind, are in greateſt perfection in the warmeſt ſeaſons, as in the latter part of June, July, and the beginning of Auguſt; when a moderate degree of ſtimulus was required, and their diaphoretic effects deſired to be promoted, the latter part of May, and beginning of June, and from the latter part of Auguſt, to the end of September, are more proper; and where we uſe them with an intent to promote the urinary evacuation, as mild diuretics, as in gravelly complaints and urinary obſtructions, there the months of March, April, and beginning of May, and the month of September, and beginning of October, would be preferable.

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* Diuretic and diaphoretic medicines, as the ſaline draught and nitre, often prove cathartic in very cold weather.

I beg here to be underſtood to mean only, that the waters are moſt likely to produce the above mentioned effects at the ſeaſons there ſet down, not to forbid their uſe at other ſeaſons, even though they ſhould be then uſed to promote an intention to which the ſeaſon is not adapted.

The effects of the waters are ſo modified by cuſtom and peculiarity of conſtitution, and other accidental circumſtances, as not to admit of any determinate rule to be laid down concerning them. Thus I have ſeen them prove diuretic in a warm, and diaphoretic in a cold ſeaſon; and I am inclined to think, on the whole, that when they are indicated in the habit and conſtitution, that no ſeaſon of the year whatever ought abſolutely to forbid a cautious trial of them, ſince more would be, probably, loſt by the delay, than gained by trying them only at a time when they might be moſt likely to prove efficacious. Formerly great ſtreſs was laid on the time of year at which the waters themſelves were in greateſt perfection; but as far as we are able to judge, the qualities of the waters remain the ſame at all of theſe, as the ori-

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gin of the ſprings probably lies too deep to be affected by rains, froſt, heat, or other changes of the atmoſphere.

The next queſtion which I ſhall enter upon is,

6. What length of time it is proper to continue the uſe of the Bath Waters.

This queſtion, as well as the foregoing, can be treated only on general principles.

In order to judge of this properly, ſeveral things muſt be taken into conſideration, as the choice of the waters, their ſtate when drank, the quantity and ſeaſon of the year, and conſtitution of the patient, but ſtill we muſt principally attend to the indication we deſire to promote. When uſed with a ſtimulant or aſtringent intention, we ought, undoubtedly, to attend to the general cautions relative to the uſe of ſtimulants, which in this caſe affects their aſtringent quality likewiſe, as that depends, in a great degree, on their ſtimulus. It is obſerved of all diſorders that require the uſe of ſtimulants, that at firſt we reap great benefit from them, but that their good effects are deſtroyed by habit.

This ſhould caution thoſe who frequent this place not to get into a cuſtom of drinking the waters frequently, except their health required it, ſince by that means they would be likely to diſappoint their effect when they might be deſired. This obſervation, though not holding true ſo particularly of the Bath Waters as of the ſtimulant ſubſtances commonly uſed in medicine, yet is ſtill, in ſome degree, applicable to them. Hence then, when it is in our power, we ought to interrupt their exhibition in order to interrupt the habit by which their effects are loſt. This holds ſtronger if the more ſtimulant water be uſed, if it be drank freſh from the ſpring in large quantity, and at a ſeaſon of the year likely to produce inflammatory diſorders.

The uſe of them in this manner ſeems pointed out by nature, ſince the waters, though at firſt highly grateful to the ſtomach and taſte, by long uſe become diſagreeable, and ſometimes in ſo great a degree as to excite vomiting, and when thus long continued I have ſeveral times obſerved, that all the advantage before gained was deſtroyed for that period. In general, the courſe of drinking the waters, when exhibited with theſe intentions, is from three weeks to two months.

When given with a diaphoretic, antiſpaſmodic, or antiſeptic intention, and when the leſs ſtimulant waters are uſed, as the Hot and Croſs Baths, and where the ſeaſon is moderate, and the conſtitution not diſpoſed to inflammatory complaints, greater latitude may be admitted of. In general I think that the waters, when given in this manner, may be continued from ſix weeks to three months, though even in this caſe it is often found advantageous to intermit their uſe for a ſhort time, now and then, to prevent the nauſea, which their long continuance is ſo apt to induce on the ſtomach.

When the Bath Waters are given as diluents in glandular diſorders, for the purpoſe of waſhing out the lymphatic ſyſtem, and as gentle diuretics, to clear the urinary paſſages in ſlight gravelly complaints, a longer time ſtill may be allowed, and the waters may, in this caſe, be often drank with advantage, from two to ſix months, eſpecially if the Hot or Croſs Bath Waters be uſed, and not drank till ſome part of their volatile impregnation has evaporated. But though I mention them as proper to be continued longer in theſe caſes than any others, yet even here it will be often advantageous to intermit their uſe for a ſhort interval, now and then, in order to prevent them becoming diſagreeable to the ſtomach *, which has been before mentioned, as apt to occur from their long continuance.

The next article to which I ſhall ſpeak, is concerning

7. The regimen of life beſt adapted to the drinking the Bath Waters.

On this ſubject I have little new or intereſting to offer. Some writers have run out to great lengths in directions of this kind, which, though good in themſelves, are not peculiarly adapted to the preſent purpoſe, which is not to treat on regimen in general, but only as connected with the uſe of the Bath Waters.

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* Where their long uſe is neceſſary, it is often found advantageous to change the water drank for that of one of the other baths, which will frequently obviate this circumſtance.

What I have to deliver on the ſubject may be comprized in a ſhort compaſs.

As to diet, the indication muſt be conſidered, and what ſuits that beſt will in general be moſt proper. Where the waters are intended to act as ſtimulants, aſtringents, diaphoretics, or antiſpaſmodics, a moderate diet of the fleſh of full grown animals, as mutton and beef, is moſt proper, with a rather ſmall proportion of freſh vegetables, of which the roots and ſeeds are preferable to the leaves and ſtalks, and a large proportion of bread. When uſed as antiſeptics, or diuretics, as in ſcorbutic and cutaneous diſorders, the proportion of meat in the diet ſhould be leſſened, and that of vegetables increaſed; and here I ſhould think that the acrid plants, ſuch as thoſe of the ſiliquoſe tribe, and other antiſcorbutics, might be advantageouſly uſed in food. How an entire milk and vegetable diet would agree with the uſe of the Bath Waters I never had an opportunity of obſerving.

One caution, however, is neceſſary, which is, to be very careful of indulging the appetite to its full extent, when it is ſuddenly increaſed, or reſtored, by the uſe of the Bath Waters. I have ſeveral times had occaſion to obſerve, that in theſe caſes the appetite was increaſed beyond the powers of digeſtion, and on that account required to be reſtrained. As to drink, I have little more to recommend than moderation, in the uſe of fermented liquors, which is a caution particularly to be attended to, as, by exceſs of that kind, the advantage to be gained by the uſe of the waters is not only diſappointed, but great danger incurred of inducing a fever, or apoplexy, ſince theſe waters have their ſtimulant qualities greatly increaſed, when an over proportion of fermented liquor is taken during their uſe. As to choice of liquors, I know no general rule that is applicable. I have ſeen the Bath Waters agree equally well, when water alone, malt liquor, or wine, and rum or brandy diluted with water, have been taken during their uſe. How far any of theſe liquors may be more properly taken in the different diſorders, is another conſideration, and not immediately connected with the preſent ſubject, and concerning which no certain rules can be laid down. In general, it has been thought, as coſtiveneſs is ſo common an effect of the Bath Waters, that red wines in general were improper, as tending to increaſe that diſpoſition, which frequently is very troubleſome. If this effect of the waters is actually diſcovered to be increaſed by the uſe of red wine, it is, undoubtedly, proper to change the liquor; but, in my opinion, this effect is too uncertain to render it neceſſary to recommend, a priori, any change of this kind to thoſe with whom red wines are found to agree in other reſpects.

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Another circumſtance of great importance, and particularly connected with the uſe of the Bath Waters, is exerciſe.

This, in a moderate degree, in caſes where it is practicable, is eſpecially neceſſary during the uſe of the Bath Waters, in order to ſecond their effects, in ſtrengthening the organs of digeſtion, and increaſing the diuretic and diaphoretic ſecretions, which are the beſt means of their paſſing off. I believe that the method commonly practiſed in this way is extremely proper, viz. a gentle walk early in the morning, between the intervals of drinking the waters, which encourages the diuretic evacuation, and moderate horſe exerciſe at noon, to keep up the perſpiratory diſcharge. In ſhort, the neceſſity of exerciſe is ſo great in this caſe, that, unleſs it can be uſed in ſome way or other during a courſe of the waters, they are ſeldom of much ſervice. Good hours, likewiſe, are eſpecially neceſſary on many accounts, and particularly as the waters are in general found to ſucceed beſt when drank early in the morning at the ſpring head. Repoſe of mind, and freedom from intenſe thought, are likewiſe highly advantageous, as cloſe ſtudy and application not only counteract the effects of the waters, by their known effects in injuring digeſtion, but likewiſe, in general, prevent ſuch a degree of exerciſe as is neceſſary during the uſe of the waters.

I now come to the laſt head, concerning which I ſhall treat, viz.

8. Of the medicinal ſubſtances proper to be taken along with, or during the uſe of, the Bath Waters.

Theſe may be conſidered in two lights, viz. thoſe which are given to ſecond, or correct the effects of the waters, and thoſe which may be taken on other accounts during the time of drinking them, but which are not otherwiſe immediately connected with their uſe.

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I ſhall firſt ſpeak a few words with regard to thoſe medicines that may be given with the firſt of theſe intentions, viz. with the intention of ſeconding their effects. In order to judge of theſe properly, we muſt conſider the indication we deſire to promote.

In caſes where their ſtimulant effects alone are deſired, without any view to the increaſe of any particular evacuation, I think very little more can be done to ſecond their effects than to reconcile them to the taſte, and enable the ſtomach to retain them, ſince we meet with few of this kind with whom the common ſtimulants (of the ſpirituous kind eſpecially) have not been already tried without effect, and a great number, where an indulgence of this kind has been the principal cauſe of the diſorder, for the cure of which they come to make trial of theſe waters.

In general, the waters are found highly grateful, and agreeable to the ſtomach, in caſes of this kind; but we ſometimes meet with inſtances where they are nauſeated, and even rejected, either from idioſyncraſy, or from the bulk of the doſe offending the ſtomach, or from its being diſuſed to a liquor that does not contain ſome ſpirituous ingredient. What is moſt likely to obviate this effect of them I ſhall ſpeak preſently, when I come to treat of the ſubſtances to be uſed, with a view towards correcting their qualities.

When we deſire to increaſe the aſtringency of the waters, an addition to their chalybeate impregnation ſeems to be the means whereby it may be done with leaſt change induced on their qualities. If we mean to be ſcrupulouſly exact, we may here make uſe of a ſmall quantity of ſolution * of iron filings in the water of the particular Bath which is directed to be uſed, added to each glaſs, which will impart an additional chalybeate impregnation, of a ſimilar kind to that which originally exiſted in the waters. But I am inclined to think this more nice than neceſſary, and find, by experience, that a few drops of

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* If this be uſed, it ſhould be previouſly made, by putting the filings into a bottle, and filling it at the fountain head, and cloſing it immediately.

either of the artificial ſolutions of the metal, as of a ſaturated ſolution of green vitriol in water, or the tinctura martis c. ſpiritu ſalis added to a glaſs of the water, anſwers the purpoſe equally well. Where a ſtronger degree of aſtringency is required, I ſee no objection to a few grains of alum taken in the ſame manner.

Where the mineral aſtringents diſagree, a trial may be made of the vegetable; but, I confeſs, I ſhould not much recommend them in this caſe, as being uncertain in their effect, which muſt be rendered more ſo, by the neceſſary limitation of their doſe when taken in this manner, and, moreover, becauſe they change both the colour and even quality of the waters, in ſome degree, by precipitating the chalybeate part of the impregnation. On theſe accounts, therefore, I would adviſe, when ſuch are neceſſary, that they ſhould be taken in the intervals of drinking the waters, and at the greateſt poſſible diſtance of time from each doſe.

The diuretic qualities of the waters, as being generally found, by experience, to be a favourable means of their paſſing off, deſerve great attention. In order to promote

PART IV. mote this, when tardy, the dulcified ſpirits of nitre and vitriol are commonly uſed, and in general with good effect. But as the urinary organs are variouſly affected in different people, it may be of ſervice, in caſes where it is proper to encourage this ſecretion, to make trial of acids and alkalies, both in their turns, and even neutral ſalts, and to fix on ſuch as may be found moſt efficacious to fulfil ſuch intention. I would, therefore, where the above-mentioned mineral acids ſhould not produce the effect, adviſe to try, firſt, the vegetable acid, as cream of tartar, which I find, by experience, to be a powerful diuretic *. If this ſhould fail, trial may be made of alkaline ſalts, the mild eſpecially, as lixivium tartari. If this ſhould prove ineffectual, nitre may be tried, whoſe effects in this way are well known. A judicious Phyſician will ſoon diſcern whether the compound or ſimple ſalts are moſt effectual in the ſeveral circumſtances.

Next to the urinary ſecretion, the diaphoretic is generally eſteemed to be the moſt

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* I have found a draught of common whey, or, what is more efficacious, a whey made with cream of tartar, drank in the intervals of drinking the waters, very efficacious in fulfilling this intention.

moſt happy method of their paſſing off, and in ſome caſes even more eligible *.

To encourage this, then, in caſes where they do not paſs off by urine, and in ſome circumſtances in preference to it, muſt be very deſireable ſometimes. This defect ſeems to proceed from the waters proving too heating, and in this caſe the dulcified ſpirits of nitre and vitriol, and the neutral ſalts, will often ſucceed. When it proceeds from a want of determination to the perſpiratory organs, from the increaſe of any other ſecretion, a few drops of the * eſſentia antimonii, or a ſmall quantity of antimonial wine, or ſolution of emetic tartar, with a few drops of tinctura thebaic, or a little elix. paregoric. taken either with, or, what I would more recommend, an hour before drinking the waters, will ſometimes induce this effect of them very powerfully. In diſorders of the

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* In general, if none of the excretions, as ſtool, urine, or perſpiration, are ſenſibly increaſed on drinking the Bath Waters, they are apt to remain a long time on the ſtomach, impair and pall the appetite, and frequently aggravate the very diſorders they were intended to relieve.

† Eſſentia antimonii, vinum antimoniale, and a ſaturated ſolution of emetic tartar, cauſed no precipitation with the Bath Water.

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PART IV. cutaneous kind (not venereal) where * mercurial medicines are more proper, they may be uſed with the ſame intention during the uſe of the waters.

I am apt to believe, that in ſome low languid caſes, an addition to the chalybeate impregnation would have this effect.

As to their antiſpaſmodic quality, it ſeems of a peculiar nature, and connected particularly with the bowels. Many medicines may be properly taken with this intention, during the uſe of the Bath Waters, but I know none that is particularly adapted to coincide with them in this intention.

As to their antiſeptic qualities, it is not quite certain that they act by means of them. I ſhould think the beſt method to ſecond this effect would be by the uſe of ſuch methods as increaſe the diuretic diſcharge.

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* Mercurial preparations, ſuch as mercurius dulcis and corroſive ſublimate, when added in ſolution to the Bath Waters, cauſe a precipitation, and are, probably, decompoſed. On this account it would be more proper to uſe them, when neceſſary, in the intervals of taking the waters.

I ſhall now ſpeak a few words on the ſubſtances proper to be uſed, in order to correct ſome of the qualities or effects of the waters. PART IV.

And, firſt, of thoſe which ſerve to render them agreeable to the palate, or ſtomach, concerning the neceſſity of which I have before ſpoken.

Tincture of cardamoms is, I believe, the moſt commonly uſed with this intention, and ſucceeds very well. If the tinctura aromatica, or tincture of cinnamon *, are more agreeable, they may be uſed with equal propriety.

I have likewiſe ſeen a tincture of columbo root of great ſervice in reconciling the Bath Waters to the ſtomach. I have alſo found the acid † and ſweet elixirs of vitriol very efficacious in the above intention.

If their ſtimulant qualities prove too powerful, the dulcified ſpirits of nitre, or vitriol, added in ſmall quantities to the waters, are very effectual in abating their inflammatory effects, and procuring them a diſcharge by their proper outlets. Nitre, likewiſe, taken occaſionally, either in the waters, or in the intervals of drinking them, is often very ſerviceable in the ſame manner.

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* The quantity of cinnamon is too ſmall to be inconvenient, on account of its aſtringency.

† I never made the trial, but ſhould think that the paregoric elixir might be often very properly uſed on theſe occaſions.

If their aſtringency proves troubleſome, recourſe muſt be had to ſome purgative medicine. As to our choice of theſe we muſt be governed by the circumſtances of the patient. If they have proved merely aſtringent, without any inflammatory effects, if the patient be advanced in life, and of weak organs of digeſtion, a few grains of aloes, or rhubarb, with ſome other ſtomachic or carminative ingredients, taken occaſionally, will be moſt proper. If, on the other hand, the waters have proved ſtimulant, if the patient be young, or in the prime of life, with his ſtomach or digeſtion unimpaired, and eſpecially if he uſe the waters on account of any cutaneous complaint, here the ſaline purgatives, as being cooling, and at the ſame time promoting the diuretic diſcharge, which

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is here of great conſequence, may be uſed, as ſal polychreſtum, Glauber's ſalt, ſal cath. amar. ſal diureticus. Soluble tartar, or Rochelle ſalt, may be uſed with equal propriety, in ſmall quantities, in the intervals during the time of drinking the waters. I have known nitre, taken in the waters to have the ſame effect, but I imagine there are few of thoſe who frequent this place, whoſe ſtomachs would bear it in quantity ſufficient.

The diuretic and diaphoretic effects of the waters have, it is ſaid, ſometimes been increaſed to the prejudice of the patient, but ſuch caſes are very few, and owing either to ſome idioſyncracy of the patient, or elſe to their being employed in improper caſes, and, probably, the effects of the diſorder itſelf often miſtaken for them. It may, nevertheleſs, in many caſes be advantageous to have it in our power to change the determination of the waters, or the outlets by which they paſs off. Thus in ſome cutaneous diſorders, owing to obſtructed perſpiration, and other complaints owing to the ſame cauſe, as habitual laxities, &c. which often happen in conſe-

PART IV. conſequence of change of climate, the reſtoration of perſpiration is of great conſequence.

But the Bath Waters are not likely to produce this effect, in any great degree, as long as they continue to paſs off largely by the urinary ſecretions. A ſubſtance, then, which would determine them to the perſpiratory organs, muſt be of conſequence. How this will be beſt done, will be underſtood by what I have lately ſaid of thoſe medicines that encourage the diaphoretic qualities of the waters. On the other hand, in caſes where the diuretic evacuation is manifeſtly of ſervice, we might be deſirous to have the waters paſs off in this manner. This is often the caſe in ſlight gravelly complaints, and ſome cutaneous diſorders, as the leproſy, &c. wherein the increaſe of the urinary evacuation is, undoubtedly, of great ſervice. For this purpoſe, ſee what is ſaid of thoſe ſubſtances that promote this effect of the waters.

I ſhall next ſubjoin ſome obſervations on the medicinal ſubſtances which may be taken during the uſe of the Bath Waters;

chiefly with a view to their chemical qualities. I ſhall treat this very briefly, in a general manner, as it cannot be expected that I ſhould deſcant on each particular article.

SALINE SUBSTANCES.

Alkaline ſalts.

Theſe are improper during the uſe of the Bath Waters, except taken at a conſiderable interval from the time of drinking, as they alter the nature of the waters when mixed with them.

Vide Experiments on Bath Waters, p. 3.

Acids.

Theſe may be uſed if neceſſary, as they do not affect the qualities of the waters.

NEUTRAL SALTS.

Theſe may be uſed during the uſe of the waters, as they do not affect their qualities.

ABSORBENT EARTHS.

Earths of this kind, in their mild ſtate, ſeem to produce little change on the qualities of the Bath Waters, on being mixed with them. They may, indeed, perhaps, detain the volatile vitriolic acid, and haſten the precipitation of the ferrugineous particles, on which laſt account theſe ſubſtances muſt always be improper where any dependance is laid on that part of the impregnation. If any addition of that kind ſhould, however, be thought neceſſary, I would adviſe the uſe of magneſia rather than any abſorbents of the calcareous kind, on account of its laxative qualities; whereas the calcareous ones rather tend to promote a coſtive habit, which is already but too frequent an attendant on thoſe who uſe the Bath Waters. It is poſſible that the opening effects of magneſia might be increaſed, on its being mixed with the Bath Water, as it might, in part, by its attraction of the volatile vitriolic acid contained in the water, be converted into a purgative earthy ſalt, though I can ſcarce think, that the quantity formed in this manner could produce any great effect. As magneſia, however, by itſelf, poſſeſſes, in many habits, the quality of keeping the body mildly open, an addition of this kind might be often of ſervice, to be uſed with this intention, which it might, in many habits, anſwer as well, or better, than alkalines or neutral ſalts, eſpecially in thoſe where acids abound in the firſt paſſages. It ſeems not improbable, that when we deſire to increaſe the tendency of the waters to go off by the urinary ſecretions, that alkalines, or neutral ſalts, would be preferable to magneſia; but where keeping the body mildly open, and obviating acidities, were the points aimed at, magneſia might be more efficacious.

Calcareous earths, in their cauſtic ſtate, ſeem very improper additions, on many accounts, to the Bath Waters.

Lime water.

It appears by the Experiments, that a copious precipitation was generated in them, when freſh, on addition of lime water, which was, undoubtedly, cauſed by the lime in the lime water attracting the mephitic air from the Bath Water, and thus becoming mild, and of courſe precipitated. From this we may judge, that in all caſes where the mephitic air may be of ſervice, that lime water muſt be a very improper ſubſtance to be joined to it, as it abſorbs it inſtantly, and unites with it very ſtrongly. Lime water added to the Bath Water freſh, ſeems to impart no additional qualities to it, except a diſagreeable empyreumatic taſte, the calcareous earth being ſeparated in an inſoluble form, and nothing remaining of it except the ungrateful flavour before mentioned. In all caſes, therefore, where lime water may be preſcribed to be taken with a courſe of the Bath Waters, I ſhould recommend them to be taken with the greateſt poſſible interval between each. As to the metallic preparations, viz. thoſe of iron, antimony, and mercury, I have before ſpoken.

As the compound formed by admixture of milk with the Bath Waters is frequently preſcribed to be taken in the way of medicine, it will not be entirely uſeleſs to conſider here what may be the chemical effects of ſuch a combination.

Milk. The Bath Water, in the proportion of equal quantities, produces, with milk heated to the boiling point, a ſeparation of its parts, the cheeſy part dividing from the ſerous in form of a looſely cohering curd. In theſe proportions, however, the ſeparation is by no means perfect, but when made with two parts of Bath Water to one of milk, the curd is then ſeparated nearly completely; the whey thus made has little peculiarity of Taſte, and, indeed, in moſt of its qualities, by what I can find, differs little from common whey made with an acid ſubſtance, and diluted with water. By the time and apparatus neceſſary for making it, the aërial impregnation is entirely diſſipated, and it is not improbable that the ſulphureous one may be decompoſed by ſuch addition, as the whey thus made poſſeſſes very little, if any, of the peculiar taſte which the Bath Water acquires on ſtanding. On the whole, this compoſition, however ſpecious, appears to be a very incongruous one for the reaſons above mentioned; and the common pretence alledged in the defence of it, that of reconciling the ſtomachs and palates of many to the Bath Water, who would not elſe be able to bear it, ſeems by no means ſufficient to juſtify its uſe. Moſt of thoſe who come to Bath for ſtomach complaints, receive the greateſt benefit from that part of the impregnation, which by this means is entirely diſſipated; not to mention the bulk of the doſe is thus increaſed one third part, which is a matter of great conſequence in ſuch caſes. In theſe cir-

PART IV. cumſtances, therefore, if the Bath Waters give diſguſt, or are with difficulty retained on the ſtomach, it would be more adviſeable to reconcile their uſe by ſome grateful aromatic addition, and by leſſening the doſes of it, than by uſing it when its qualities are impaired, and its bulk conſiderably augmented. If whey, however, be deemed a neceſſary addition, I would adviſe a proportionable quantity of freſh whey, already made, to be added to the water, freſh drawn, and to be immediately drank, by which means the qualities of the waters will be little injured. I own that whey, drank at the ſame time with a courſe of the waters, eſpecially in the ſpring ſeaſon, might often, in many complaints, eſpecially thoſe uſually called ſcorbutic, be a very proper preſcript, as contributing to obviate the coſtive habit, and heating effects, which theſe waters ſo frequently occaſion; but cannot ſee any neceſſity for mixing it with the waters, as its good effects would be equally powerful, if taken at ſome interval. On the whole, I am inclined to believe, that this remarkable effect of the water on milk, has contributed much to recommend the product of ſuch a combination as a medicine, as impoſing, by a kind of juggler's contrivance, on the underſtandings of many, and perſuading them to believe, that ſo remarkable a production muſt have ſome very uncommon virtues. To ſum up all, this preparation ſeems incongruous to the general intentions wherewith the Bath Water is preſcribed, and not qualified to anſwer any purpoſe which might not as effectually be done by other means.

As to vegetable ſubſtances, I have before ſpoken concerning the impropriety of uſing thoſe of the aſtringent kind with the Bath Waters. But this does not affect the Bitters, except combined with an aſtringent quality. Moſt of the woods, barks, fibrous roots, ſtalks, rinds of fruits, ſome leaves, and the cortical part of ſeeds, poſſeſs ſome degree of aſtringency; whilſt, on the other hand, the pulps of ripe fruits, ſimple gums, eſſential and expreſſed oils, balſams, gum-reſins, and bulbous roots, are nearly diveſted of it. It is probable, then, that all of the latter kind, if proper on other accounts, might be taken without any alteration of the qualities of the Bath Waters.

I have thus finiſhed what I have to ſay on the ſubject of the internal uſe of the Bath Waters.

The preſent edition differs conſiderably from the foregoing, being much enlarged, and, I hope, ſomewhat improved. As to the circumſtances in which it varies, I thought it better to make this general acknowledgment at the laſt, than perplex the reader with particular references in the courſe of the work. Where it varies, I think I have had ſufficient reaſon for altering my opinion. I at firſt propoſed to have included my ſentiments on the external uſe of the waters in this Volume, but found the ſubject ſo copious, as to render an abridgement of it neceſſary to bring it within its preſent compaſs.

The ſecond Volume, on the external Uſe of the Waters, will be publiſhed ſeparately in a moderate time.

Whether I have ſucceeded in my attempt, the world will judge. I confeſs that the preſent work is defective in ſeveral reſpects, but I flatter myſelf, nevertheleſs, that as the general plan is, I believe, tolerable, and the facts not (intentionally at leaſt) miſrepreſented, that it may not be entirely uſeleſs to the world if it furniſhes any materials or hints upon which ſome more able Writer may enlarge.

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SOCIETY

ERRATA.

THE Author being at a diſtance from the Preſs, the following Errata have happened, which the Reader is deſired to correct. Perhaps more may have paſſed unnoticed, but it is hoped they are principally in the punctuation only, and ſuch as may be corrected by obſerving the general ſenſe of the Work.

Page 42, line 1, place ACIDS a general title.

P. 42, l. 3, place VITRIOLIC ACIDS as a title to the paragraph.

P. 49, part of line 9, and lines 10, 11, inſerted by miſtake.

P. 94, inſert as a note to the title *Regenerated Tartar.*—Regenerated Tartar, formed by the acid of Tartar, and the vegetable, alkali is of a leafy foliated texture, remarkably deliqueſcent, though probably this quality is owing to too quick an evaporation of the water, in order to its cryſtallization. It diſſolves eaſily, and in a ſmall proportion of water, and generates heat with it. It is of eaſy fuſion on the fire. It alſo diſſolves in ſpirit of wine, and is ſaid to promote the action of that fluid on gummy and reſinous bodies, and even renders oils miſcible with it, if not ſoluble in it. It promotes the action of alcohol on the calces of metals. It is generally thought that the different kinds of vegetable acids form ſalts of different qualities, but their diſtinguiſhing properties are not yet aſcertained clearly.

P. *ibid.* Inſert as a note to the title *Salt of Rochelle.*—Sal Polychreſtum Rupellenſe is formed of the acid of Tartar and the foſſil alkali. It cryſtallizes eaſily, and keeps dry and even calcines in the air. It is not of ſuch eaſy fuſion in the fire, nor ſo ſoluble in water, as regenerated Tartar. It is not ſoluble in ſpirit of wine. It is decompoſed in the ſame manner as regenerated Tartar.

P. 95, inſert as a note to the title *Vegetable Ammoniac.*—This is, probably, of as great variety as the vegetable acid, but as we ſee it, it is formed from vinegar and the volatile alkali. It is as we ſee it in a fluid form, though it may be got ſolid, though with difficulty. It renders oils ſoluble in ardent ſpirits, and promotes their action on gums, reſins, and metallic precipitates, like regenerated Tartar.

For the means by which this, and the two foregoing ſalts may be decompoſed, vide table of Elective Attractions, end of Part I.

P. 105,

ERRATA.

P. 105, l. 7, ab imo for *its* read *their*.
P. 110, l. 13, ab imo for *But* read *And*.
P. 120, at Ardent Spirit, line 3, ab imo, inſert SECT. III.
P. 161, l. 12, ab imo, read, *left* the fluid above clear.
P. 171, l. 1, a ſummo, inſert as a title to the paragraph, MAGNESIA.
P. *ibid.* l. 11, inſert as a title to the paragraph, CRYSTALLINE EARTHS.
P. 172, l. 4, for *Magraaf* read *Margraaf*.
P. *ibid.* l. 10, as a title, read ARGILLACEOUS EARTHS.
P. 173, l. 6, omit *in three ounces.*
P. *ibid.* l. 10, inſert as a title TALKY EARTHS.
P. 185, lines 7, 8, and part of 9, inſerted by miſtake.
P. 225, l. 5, ab imo, the ; ſhould be placed after the word *Selenites* line 4.
P. 258, l. 1, for *contained* read *imparted*.
P. 322, CHAP. IV. read CHAP. I.
P. 364, l. 12, for *Antiſcorbutic* read *Antiſpaſmodic*.